POWER

Volume 62 New York, September 1, 1925 No. 9

The Bureau of Mines

ONCE in a while some politician becomes statesman long enough to realize that the people have a common interest in the effective management of the natural resources of the country in which they live, however remote their personal interest in those resources has become.

In 1910 the Congress established in the Department of the Interior a Bureau of Mines, whose function it has been to conduct scientific and technologic investigations regarding the mining and utilization of our mineral products, to inquire into the economic conditions affecting the mining industries, to investigate the fuels and products still belonging to the people and to disseminate information concerning these subjects.

The scientific and technologic work of the Bureau has been of the highest order and has served many useful purposes. Its coal analyses form the basis of our knowledge of the properties of American coals. Its studies of combustion processes are fundamental and have influenced the thought of every combustion engineer. Its work upon house-heating boilers and fuels for them has placed valuable information at the hand of the householder. It did early work in pointing the way to the use of bituminous coal in water-gas sets. Its microscopic studies of coals has thrown much light upon their origin and structure. It has worked out methods for correctly sampling coal in large quantities, for storing coal with precautions against spontaneous ignition. It has assisted in the development of the processes of burning pulverized fuel. It has investigated the explosiveness of dust in mines, and done much to reduce the dangers and discomforts of mining and to aid in rescue work when accidents have occurred. It has studied the possibilities of our enormous deposits of peat and lignite. It has combated fuel fallacies and aided in developing and disseminating correct ideas regarding fuel use. It has helped in the solution of the smoke problem. These illustrations are drawn from but one phase of the Bureau's work.

By a recent executive order the Bureau has been transferred from the Department of the Interior to that of Commerce. While under its basic law the means and facilities of the Bureau might be diverted to making "inquiries into economic conditions," and while there are economic conditions that may be profitably inquired into by somebody holding a brief for the people, the friends of the Bureau are hopeful that this work if undertaken, will be supplementary to and not subversive of the good technical work which has made the statements of the Bureau respected when others were in doubt.

F. R. Low

Power and Heating Load Supplied by Non-Condensing and Condensing Turbines

By ALFRED IDDLES
Chief Power Engineer, Day & Zimmermann, Inc., Philadelphia, Pa.

AN INDUSTRIAL plant in which live steam was used for heating and process work and non-condensing engines for prime movers has been rebuilt for combination condensing and non-condensing turbines. The non-condensing turbine operates over a steam range of 200 lb. gage and 100 deg. F. superheat to 50 lb. gage, at which pressure the heating and process requirements are supplied. The power requirements beyond those supplied by the non-condensing unit are taken care of by a condensing turbine.

ORIGINALLY, the Scranton Lace Co.'s power plant was equipped with hand-fired water-tube boilers, burning anthracite coal of rice size, and furnished steam for process purposes and also to a Corliss engine belted to direct-current generators. Recent additions to the plant were supplied by alternating-current. The age and inadequate capacity of the power- and steam-producing equipment caused the owner to invite his consulting engineers to make a study of the plant and contemplated building program to determine the best way to provide the service required by the manufacturing departments. The engineers made a survey to determine the quantities and qualities of energy and heat needed. While nearly all the electrical power used was in the form of direct current, it was found that most of the motors were operated at constant speed and that practically all future loads would require constant-speed drive.

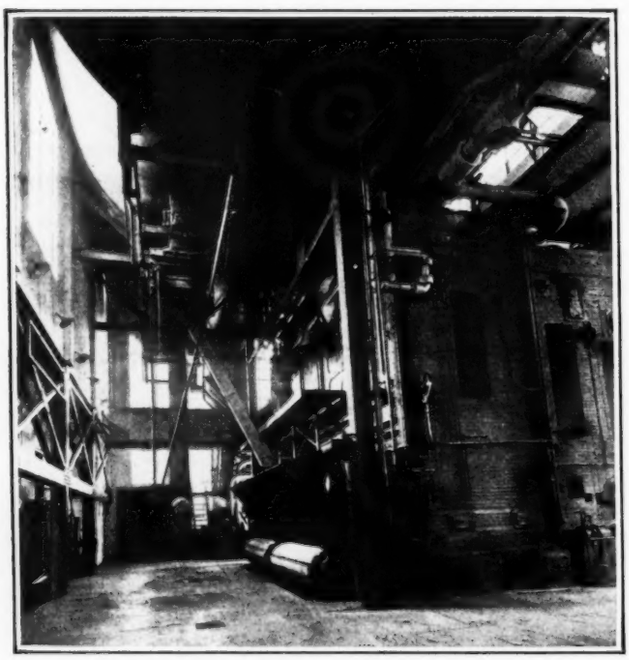


Fig. 1—The two 5,000-sq.ft. boilers can be operated up to 250 per cent rating

Boiler plant equipped with overhead coal bunker, traveling weighing larry and forced-draft chain-grate stokers. Ashes dumped directly from stoker hoppers into auto trucks for removal.

Fig. 2—Cooling tower for condensing turbine is on roof of power house

A study of the plant records showed that the average monthly kilowatt-hours requirement was 97,300, a yearly power production during 11½ months of 1,119,000 kw.-hr. and a peak load of 350 kw. The average load during the hours of operation, expressed in kilowatts, was found to be equal to one-half of the connected load expressed in horsepower. A load of 100 kw. for new machines and for a local coal mine operated in connection with the boiler plant, was added to the actual load and 450 kw. determined as the probable peak load in the near future.

The building heating was cared for by 9,778 sq.ft. of direct radiation and 21,020 sq.ft. of indirect fan-blast radiation. In the latitude of Scranton this radiation indicated a peak-load steam requirement equal to 18,500 lb. per hour and an average steam consumption of 6,100 lb. per working hour throughout the heating season of 200 days. In addition there was steam required to heat the buildings during non-working hours.

The steam for heating could be satisfactorily supplied at 2 to 5 lb. gage pressure. Steam was required for process purposes at pressures varying from 10 to 40 lb. A summary of all steam requirements is as follows:

	Average, Lb. per Hour	Peak Load, Lb. per Hour
10-Lb. steam:		
Process	8,380	10,000
Heating	6,100	18,500
40-Lb. steam:		
Process	2,165	3,000
Total steam required	16,645	31,500

From the foregoing it is evident that a large amount of steam is required at 10 to 40 lb. for processes and heating. For this reason and that nearly all the piping in the mill had been installed for transmission of steam at from 25 to 100 lb., it was considered advisable to develop a scheme to produce process steam at a maximum pressure of 50-lb. gage. This made it possible to distribute the steam throughout the mill for heating and process purposes in the existing piping system, and with this pressure available no live steam would be required at any place in the plant.

To the foregoing steam requirements were added the steam necessary to operate the boiler-plant auxiliaries, the pipe radiation and other losses. Guided by the plant operating schedule, it was determined that the average yearly steam needed was about 80,000,000 lb. at present and only slightly greater in the near future. This worked out as requiring boiler capacity totaling about 10,000 sq.ft. of steam-making surface.

RELATION BETWEEN STEAM REQUIRED FOR HEATING AND THE ELECTRIC LOAD*

Time	Average Electrical Load, Kw.	Exhaust Steam Requirements, Lb. per Hr.	Deficiency—Minus Excess—Plus Steam Exhaust Lb. per Hr.	Live Steam for Electric Load and Heating Lb. per Hr.
		Summer		
Day.....	350	10,500	Plus 7,000	13,650
Night....	130	1,000	Plus 5,000	3,300
		Winter		
Day.....	350	16,750	Balanced	16,750
Night....	130	8,375	Minus 3,00	8,375

*Based on a live-steam condition of 200 lb. gage and 100 deg. F. superheat supplied to the turbines.

The table shows the relationship between the average electrical requirements of the mill and the average low-pressure (50-lb.) steam requirements. It is assumed that 200-lb. steam at 100 deg. F. superheat is supplied to a turbine and exhausted at 50-lb. gage pressure. The fourth column in the table indicates the deficiency or excess of exhaust steam. The excess exhaust steam in the summer should be condensed in order to obtain a better turbine water rate for that energy needed over and above what could be produced by expanding the steam from 200 to 50 lb. During daytime in the summer, 10,500 lb. of exhaust steam is required for process

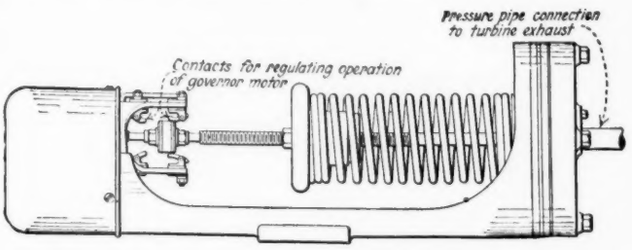


Fig. 4—Regulator for automatically dividing the load between the condensing and non-condensing turbines

work and heating. If all the power load was produced by expanding the 200 lb. steam to 50 lb., there would be an excess of 7,000 lb. of exhaust, or a total live-steam requirement of 17,500 lb. By operating one turbine at a load to supply the exhaust requirements and another turbine condensing, the total live-steam requirements are 13,650 lb. as given in the right-hand column. The deficiency of exhaust steam, indicated at night time in the winter, can be furnished to the steam distribution mains direct from the boiler through reducing valves.

Owing to the age of the existing boiler plant and to its state of obsolescence, it would be necessary to replace the entire equipment within a short time; besides, the capacity of the plant was insufficient to

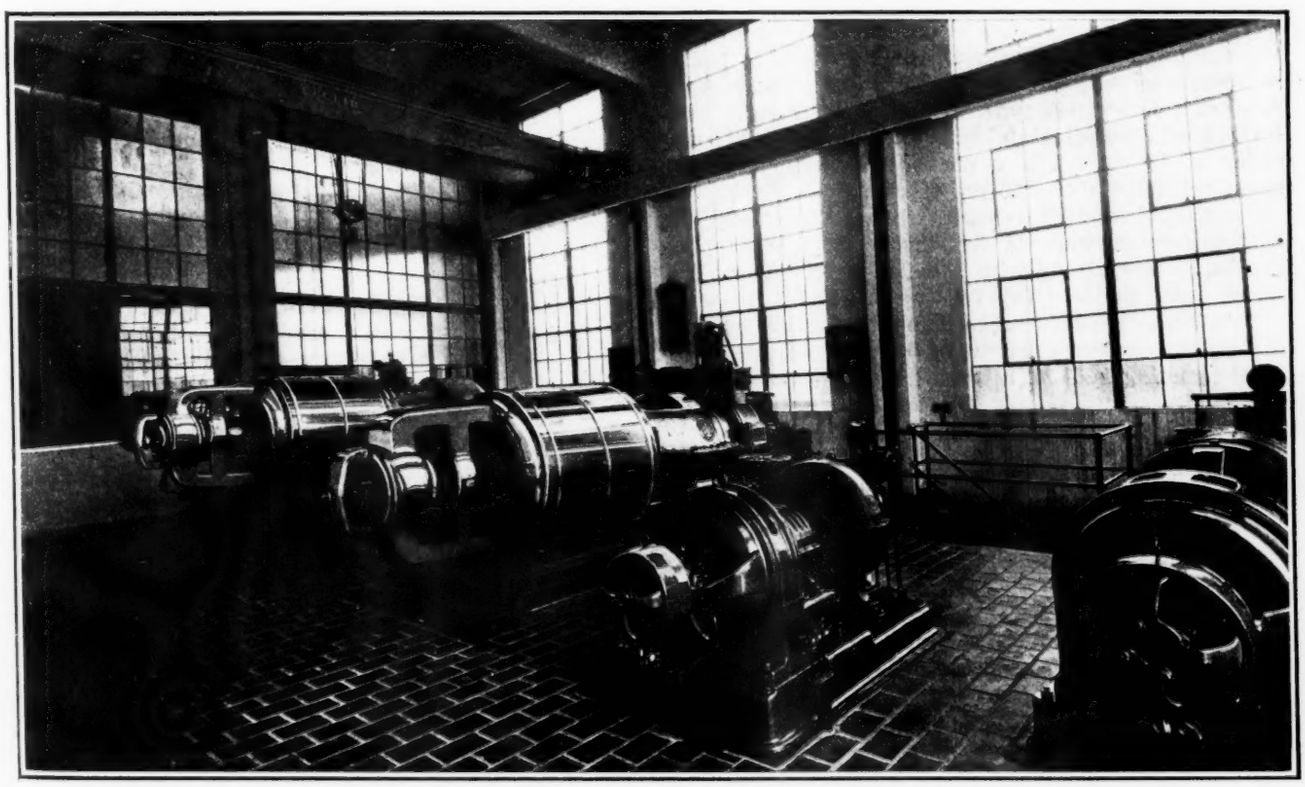


Fig. 3—Alternating current is generated at 220 volts

The power plant contains one 500-kw. non-condensing turbine, one 500-kw. condensing turbine, a 100-kw. direct-current generator driven by a synchronous motor and non-condensing steam turbine and a 30-kw. turbine-driven alternator.

meet the new steam requirements. Estimates of construction and operation costs were therefore made, and a study of these indicated the desirability of constructing an entirely new boiler and power plant.

The new boiler plant consists of two 5,000-sq.ft. horizontal water-tube boilers built for 225 lb. gage and 100 deg. F. superheat, Fig. 1. A pressure of 205 lb. is carried at the outlet of the superheater. Forced-

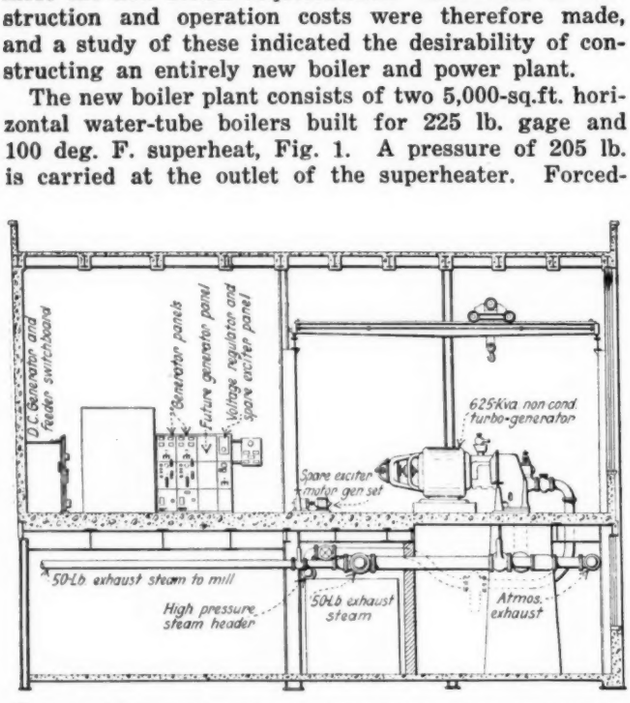


Fig. 5—Non-condensing turbine exhausts against 50-lb. gage, back pressure

draft chain-grate stokers are installed with the usual ignition arch and a rear arch arranged to deflect the lean gases from the rear compartment toward the front where they can meet the unburned gases from the front portion. One motor and one geared-turbine driven forced-draft fan are installed on the boiler-operating floor at one end of the plant, and provision is made for operating the boilers up to 250 per cent rating. Cast-iron ash hoppers with steam-operated gates are provided with sufficient basement headroom to permit driving a motor truck under the ash hoppers for removal of ashes direct to the truck.

A radial-brick stack provides the draft, and automatic apparatus controls the draft and air supply. Each boiler is equipped with a boiler meter and multi-pointer draft gages. The feed-water heater is on a platform above the boiler-feed pumps, which are on the boiler-operating floor adjacent to the forced-draft fans.

Coal handling is from a track hopper at the end of the plant through a bucket elevator, onto a flight conveyor which distributes it into a suspended steel bitumastic enamel-lined bunker. Distribution from the bunker to stoker hoppers is by a traveling weighing larry.

Cost of Producing Steam

The new boiler plant is producing steam at a cost exclusive of fixed charges of 15 per cent less than that in the old plant. In addition it has ample capacity for the load and produces steam of sufficient pressure to enable the production of power by reducing steam from 200 lb. gage and 100 deg. F. superheat to 50 lb. gage, in which condition it serves all heating and process needs which otherwise and heretofore were mostly supplied by high-pressure steam directly from the boilers.

Space has been provided for a third boiler to supply the increased needs when additional manufacturing facilities are provided. The space available for power apparatus and simplicity of the installation and operation, indicated turbines to be the most desirable prime movers for power generation.

An examination of steam and electric load curves showed that the demands for power and for process and heating steam did not correspond; especially there is a demand for power during the night shift in the summer with no steam needed.

The peak load did not exceed the capacity of a standard 500-kw. 80 per cent power-factor generator. Hence two 500-kw. turbo-generators were selected each with a direct-connected exciter. One turbine is operated non-condensing, exhausting at 50-lb. gage maximum back pressure, and the other is a condensing turbine exhausting to a surface condenser supplied with cooling water from a cooling tower erected on the power plant roof.

Load Divided Automatically Between Condensing and Non-Condensing Turbines

The non-condensing turbine is fitted with a governor which maintains the pressure in the exhaust main constant at 50 lb. as long as there is sufficient electrical load in the plant. The two 500-kw. units operate in parallel on the electrical end. The load is shifted from one machine to the other by the action of the automatic back-pressure regulator, Fig. 4. The regulator consists of a diaphragm connected on one side to the exhaust of the turbine, the pressure being balanced by a coil spring. If the exhaust pressure rises owing to reduced mill requirements for steam, the regulator com-

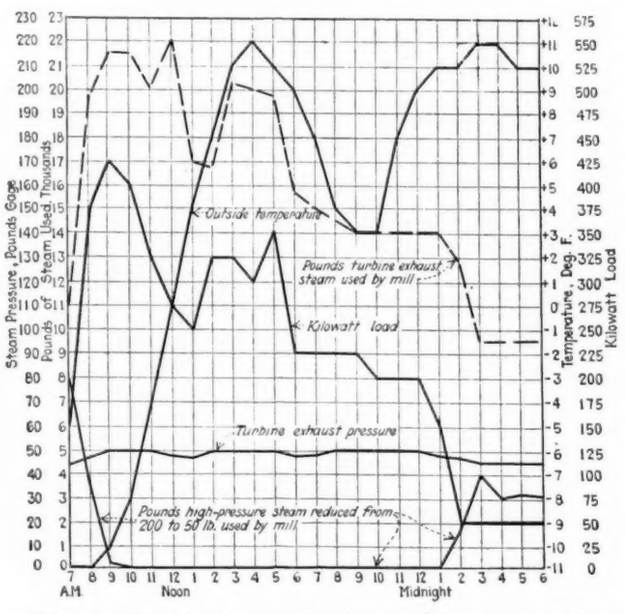


Fig. 6—One day's record of power-plant operation

pletes a circuit through two of its contacts, causing the governor motor on the non-condensing turbine to move to change the governor-spring tension. This shifts some load to the condensing turbine, thus decreasing the amount of 50-lb. exhaust steam produced and re-establishes the 50-lb. pressure in the exhaust main. If pressure in this main falls below 50 lb., the reverse takes place and the load on the non-condensing turbine is increased. This arrangement functions so that all or any part of the electrical load is carried by the non-

condensing turbine to produce just enough 50-lb. steam for the mill requirements, up to its maximum electrical load. Fig. 6 shows, along with other conditions, one day's record of exhaust-steam pressure. If the mill requires more 50-lb. steam than can be produced by the non-condensing turbine when carrying all the available electrical load, the remainder is supplied automatically through reducing valves direct from the high-pressure mains.

In case of trouble with either turbo-generator the other can carry the entire plant electric load, but with some temporary waste due to exhaust to the atmosphere or steam to the condenser while other steam is being passed to the mill through reducing valves.

In this plant steam from 200 lb. and 100 deg. F. superheat to 50-lb. pressure is utilized to produce power for a much smaller heat energy consumption than can be done by the largest and most efficient central station. This can be done because of the large requirement for exhaust steam.

Automatic Regulator Controls Back Pressure

The automatic regulator controls the back pressure within 5 lb. Fig. 7 shows this pressure variation on a recording instrument chart. This chart is from a recording steam-flow meter registering the amount of exhaust steam at 50-lb. pressure passed to the mill for

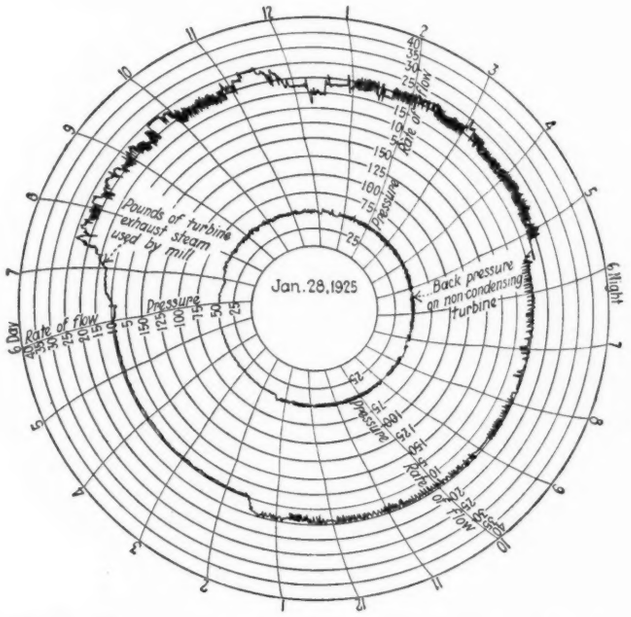


Fig. 7—Meter record of back pressure on non-condensing turbine and exhaust steam use

heat and process use. Fig. 8 shows the amount of steam passed to the mill through reducing valves to supply the deficiency in exhaust steam at 50-lb. pressure when the electric load was less than needed to enable the turbine to maintain the 50-lb. exhaust pressure. Fig. 6 shows the electric load curve plotted with the exhaust-steam load curve to show the dissimilarity of the loads at times, and the other periods when the loads are similar and the majority of electric power is produced by the non-condensing unit.

There is a connected load of about 435 hp. in direct-current motors. This power is supplied by a 100-kw. 230-volt direct-current generator driven by a synchronous motor operating at 220 volts direct from the alternating-current busbars through proper control equipment. This direct-current generator also has a steam turbine direct connected on the other end of the shaft from the motor. The synchronous motor is arranged to operate as a generator if desired. The steam turbine is rated at 150 hp. and can be used to drive the direct-current generator in case of trouble

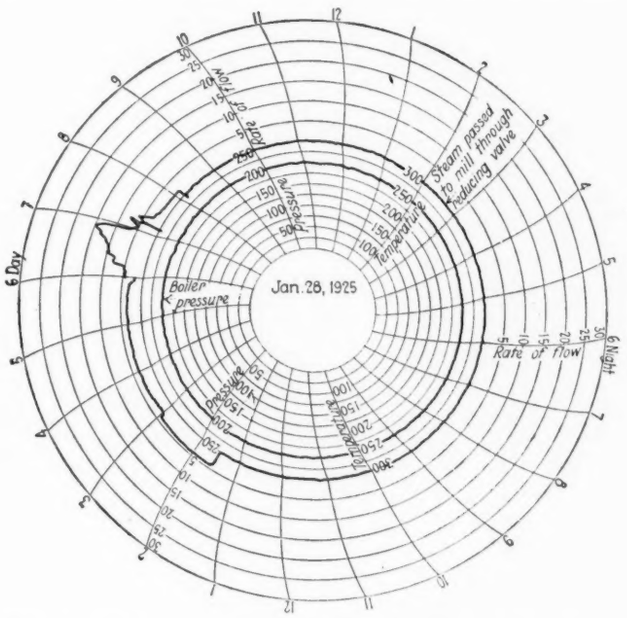


Fig. 8—Meter record of boiler pressure and live steam passed to mill through reducing valve

with the synchronous motor, or it can and frequently does drive both generator and motor to produce direct current and alternating current for night, Sunday and overtime operation. This turbine exhausts to the feed-water heater and atmosphere. With spare direct-current generator parts and two prime movers a satisfactory degree of security for continuous direct-current supply is obtained.

Lights for the plant, when no operation is going on, are supplied by a 30-kw. turbine-driven alternating-current generator. The turbine exhaust is connected to the feed-water heater and atmosphere.

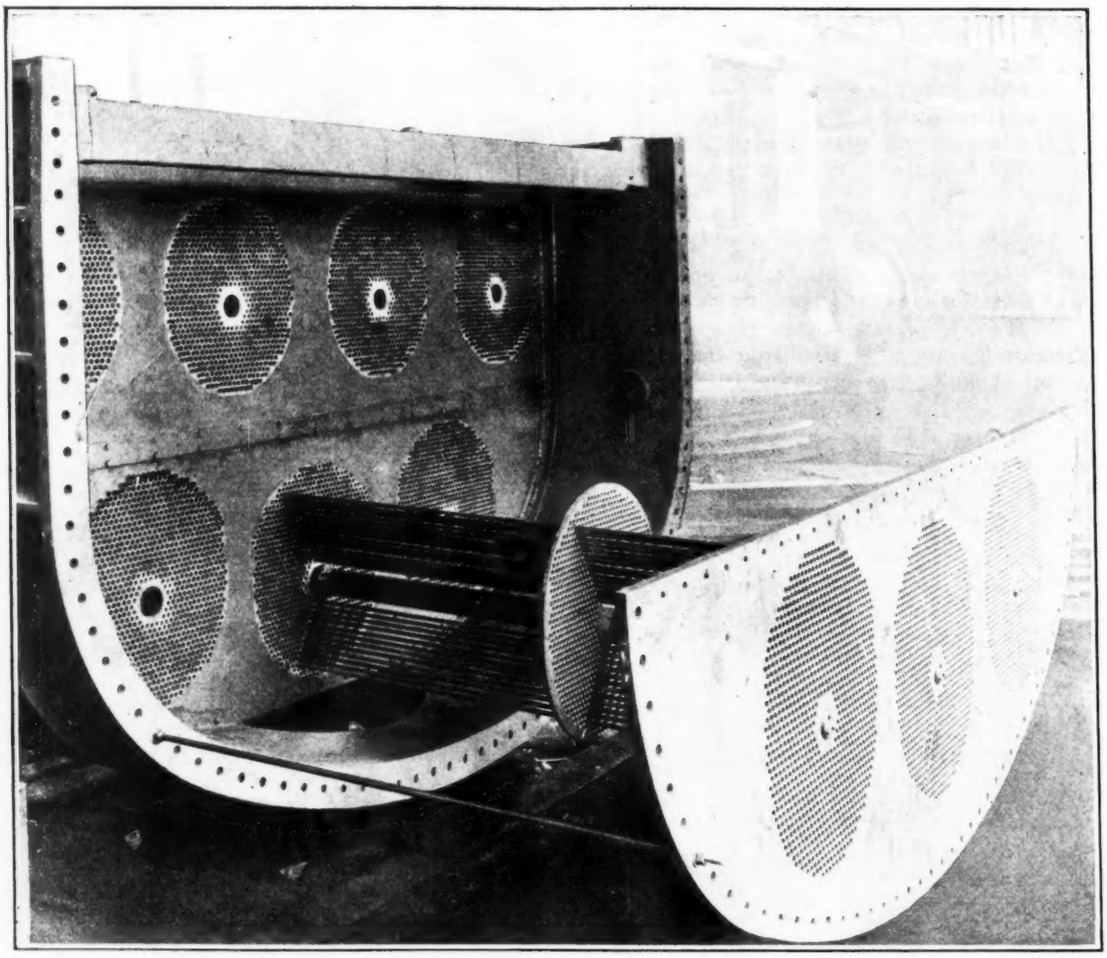
There is a glass partition between the boiler and turbine rooms, and since both operating floors are on the same level a minimum of operating labor is required.

The boiler and turbine plant layouts and fundamental designs were made by Day & Zimmermann, Inc., who also made the detail design of the turbine plant and supervised its construction. The boiler equipment was purchased and boiler-plant construction handled by the Scranton Lace Co., for which Mr. Yerrick is designing engineer and Robert Raine, chief operating engineer. All building work was done by Aberthaw Construction Company.

Leaky dampers on boilers out of service or on bank may add materially to the power consumed by the induced-draft fans. It is well to check these over occasionally.

The Vacuum Tube Condenser

AN UNUSUAL name has been chosen for the type of single-pass condenser shown in the figure. Instead of a single fairly compact group of tubes, this design of the Wheeler Condenser and Engineering Co. for a 30,000-sq.ft. single-pass unit serving one of the two 35,000-kw. General Electric turbines installed by the New York Edison Co. at its Waterside Station has in all seven distinct clusters or bundles of tubes. By this means large tube surface and steam flow areas are exposed to the exhaust steam.



Non-condensable gases are withdrawn from each tube cluster individually

Running lengthwise through each cluster of tubes slightly below the center is a perforated pipe or "vacuum tube" for the removal of non-condensable gases. Such gases as are left after the condensation of the steam in each cluster, instead of settling down to blanket the tubes in the lower part of the condenser are therefore removed directly from the cluster in which the steam was condensed. The short length of flow passage from the surface of the cluster to the dry pipe at the center minimizes the pressure drop between the turbine exhaust and the air-pump suction. All the steam must travel through the same depth of the tube bank before reaching the dry pipe.

High coefficients of heat transfer, such as were more easily obtained in small condensers formerly than large ones, are the object of this design which is in a way the multiplication of small condensers with relatively short steam paths through the tube banks.

All the tube clusters and dry pipes pass through a central air box connected to the vacuum pump. In passing outward from each vacuum tube into the air box, the non-condensable gases must again traverse the tube clusters and are thus effectively cooled and devaporized. The air pump therefore is not called upon to handle large quantities of water vapor. The converging path of the steam from the surface to the center of each cluster prevents air blanketing of the tubes by maintaining sufficient steam velocity.

The condensate is heated by falling through the steam space. High condensate temperature is indicated.

FROM ACCEPTANCE TEST OF 30,000-SQ.FT. CONDENSER

Load, kw.	30,000
Vacuum, inch	28.59
Temperature, inlet water, deg. F.	66
Temperature, outlet water, deg. F.	79
Vacuum temperature, deg. F.	90
Condensate temperature, deg. F.	90
Pounds of steam condensed per hour	345,000
Gallons of cooling water per minute	53,100
Heat transfer, B.t.u. per sq.ft. per deg. temperature difference per hour (calculated from arithmetic mean temperature difference)	657

Air Compressor Explosions

By Charles H. Bushnell

LET us assume a non-conducting compressor cylinder fitted with a frictionless piston as in Fig. 1. Work done in compressing air in this cylinder will appear in the form of heat. The cylinder being non-conducting the temperature after compression will be $T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{.29}$ and all of this heat will be carried away by the air passing out the discharge valve.

As a second case let us consider a non-conducting cylinder fitted with a frictionless piston but having considerable clearance volume and no valves, as shown in Fig. 2. The air contained in this cylinder is repeatedly compressed and expanded. The work done on the compression stroke will be returned to the piston on the expansion stroke. The temperature will increase with compression and decrease with expansion, in accordance with the formula already given. As there is no net work done in driving this machine or power derived from it, there can be no net gain or loss of heat. This is true within practical purposes, but would be absolutely true only with a perfect gas.

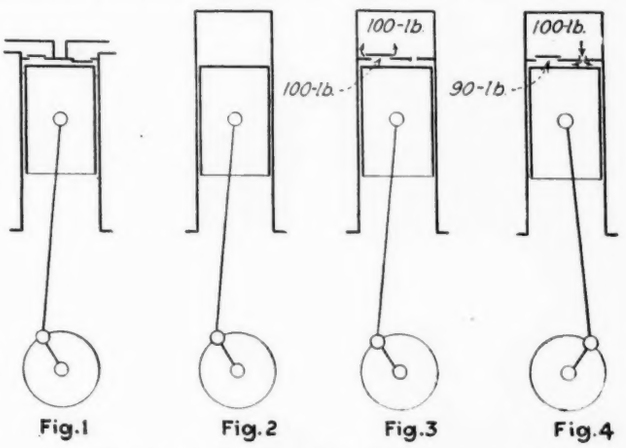
A non-conducting cylinder and receiver connected by a discharge valve and a comparatively small orifice is shown in Figs. 3 and 4. The air contained is repeatedly compressed by the frictionless piston. On the compression stroke the pressure in the cylinder and receiver will be equal, while on the expansion stroke the pressure in the cylinder will be less than that in the receiver owing to the restricted flow of air through the orifice. It is obvious that there is a greater amount of work done on the compression stroke than is recovered on the expansion stroke. The net result is that there is a certain amount of work done each cycle in driving this machine. As this work is converted into heat, the temperature of the air will be increased indefinitely.

The condition in an actual compressor having a leaky discharge valve will be between that of the first and third cases, depending upon the magnitude of the leak. It will also be modified by the cooling effect of the cylinder walls, the restriction of the valves and the friction of the piston.

How much increase in temperature is necessary to ignite oil? There is much confusion here. The flash point is the temperature to which a sample of the oil must be heated under certain standard conditions to give off sufficient vapor to flash in the presence of an open flame. The fire point or burning point is the temperature to which it must be heated to continue to burn after being ignited by an open flame. The ignition point of oil is the temperature at which it will take fire without being exposed to a higher temperature. The ignition point has no direct or indirect relation to the flash and fire points, as is shown by the values given by Holm, Harold Moore, and the United States Bureau of Mines. The values given differ somewhat owing to the method used in their determination, but there is little difference between those of gasoline, kerosene and compressor oils. Time is an important factor in the ignition point as has been shown by Commander Hawkes. Within certain limits the greater the time interval the lower will be the ignition point, and the pressure does not affect the result.

It is well known to those who have experimented with cold-starting oil engines that it is not possible to obtain ignition in a cold cylinder with a compression-pressure ratio of much less than twenty to one. Even then the oil must be sprayed into the hottest portion of the air. Oil clinging to the cylinder walls will not be ignited in an engine cylinder with momentary temperatures as high as 3,000 deg. F. It does not seem possible to ignite oil under any conditions in an uncooled compressor cylinder with a compression ratio of less than fifteen to one. Ignition beyond the discharge valve is possible at a considerably lower temperature because of the continuous heat.

Before there can be a fire in a compressor, there must be an accumulation of combustible material. If all the oil fed to a compressor were burned as it entered, the amount is so small that it would have no appreciable effect. Any oil exposed to air at a high temperature will in time either evaporate or be decomposed,



Figs. 1 to 4—Events in air compressors

or carbonized, as it is commonly called. As a general rule the lower the flash point the greater will be the portion vaporized and the less carbonized. If gasoline or kerosene were fed to a compressor in any amount within reason, it would simply be vaporized and carried over to the cooler or receiver. As their ignition point is high, they could not be ignited by any compressor in proper working order.

Carbon, combustible dust and some oil can and often do accumulate in compressor passages. This may be ignited by the increased temperature due to a leaking discharge valve. Restricted passages may also have some effect in raising the temperature. Such a deposit cannot burn explosively any more than a chunk of coal can, although the weakening effect of the heat together with an increased pressure may cause a rupture of some part. It is possible that this burning might produce enough carbon monoxide and oil vapor to form an explosive mixture in the receiver which might be ignited by flame or bits of burning carbon.

The foregoing leads to the following conclusions:

Use a low flash-point lubricating oil.

Do not use more oil than necessary, although one should not allow a compressor to run dry.

Exclude all combustible dust.

Keep the valves in good condition.

Remove such deposits as cannot be prevented. The practice of using soap to do this is open to question, as it is possible for the soap to carbonize and burn.

Deshler, Ohio, Municipal Light Plant

Village Installed Oil Engines in the Light and Water Plant— Total Cost per Kilowatt-Hour Approximately Two Cents

AT ONE time Deshler, Ohio, was served by two electric distributing systems, one owned by the municipality which was supplied with energy by a transmission line, and the second owned by a public utility whose plant was in a neighboring city. Purchase of the latter company by the transmission system placed the municipal authorities in the position where it was impossible to purchase electricity for distribution. The installation of a generating plant was deemed preferable to the abandonment of the municipal distribution lines, and a structure was built adjoining the building containing the motor-driven water-works pumps, and two oil engines were installed in 1923.

These engines are two-stroke-cycle medium-compression oil engines built by the Fairbanks Morse & Co., and were direct connected to 125-kva. 2,300-volt alternators, the exciters being belt driven from the engines. The operation of these engines was so satisfactory that a third 150-hp. unit was installed in January of this year. This machine has a compression of approximately 480 lb. and is cold starting. In many respects it adheres closely to the design of the earlier engines, although several devices have been added to assist the engineer to obtain best results. Each exhaust outlet is provided with a pyrometer, the lead of which runs to a four-point dial on the switchboard. By adjusting the engine so that the exhaust temperature of all the cylinders are alike, proper load balancing of the machine is obtained. The exciter is driven from the generator shaft by a short chain belt. This reduces the flow space required by the unit.

To reduce the lubricating-oil cost, an oil reclaimer has been installed, and the oil draining from the crankcases is clarified by batch treatment in the reclaimer. The cooling water is obtained from the wells supplying the water works, and as the temperature increase in the jacket water is small, but a slight rise is shown in the water going to the tower tank.

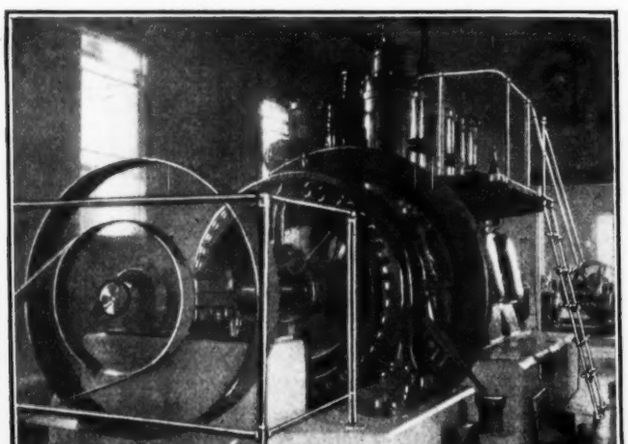


Fig. 1—One of the 150-hp. oil engines

The cost of the plant as it now stands is shown in the tabulation.

INVESTMENT COST	
Engines, generators and auxiliaries	$38,700
Foundation and buildings	8,000
Total	$46,700
FIXED CHARGES	
Interest on investment, 5 per cent	$2,335.00
Depreciation on building, 4 per cent	320.00
Depreciation on machinery, 5 per cent	1,935.00
Insurance on engines, 1 per cent	387.00
Total fixed charges	$4,977.00

The installation of three units permits the generating units to be run at a high load factor regardless of the live load. Consequently, the efficiency is high, and while the yearly plant-load factor is approximately 35 per cent, the machine-load factor approaches unity. From June, 1924, to June, 1925, the output and operating costs are as given in the following tabulation:

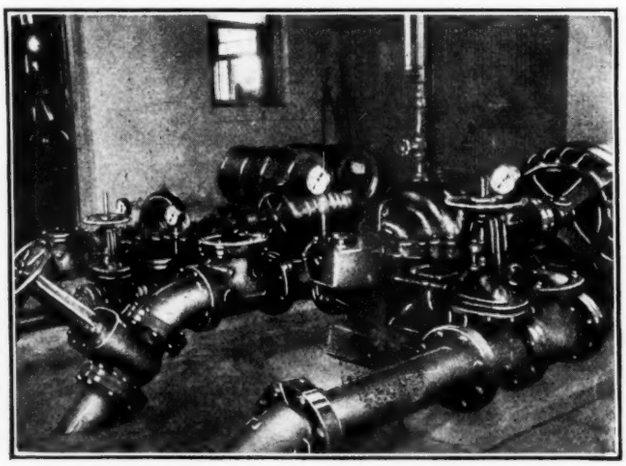


Fig. 2—Motor-driven centrifugal pumps supply the water service

Total engine operating hours	9,150
Kilowatt-hour output	604,800
Fuel consumption, gal.	60,123
Grade of fuel, Beaumé	35 to 40
Lubricating oil, gal.	960
Cost of fuel	$3,607.38
Lubricating oil cost	576.00
Supplies	125.00
Labor	3,360.00
Repairs	7.60
Total	$7,675.98

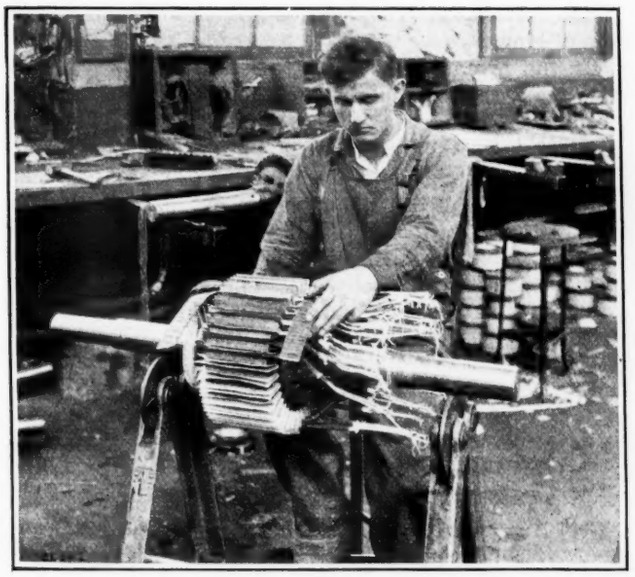
Figured in terms of cost per kilowatt-hour, the year's record was as follows:

	Total Cost	Cost per Kilowatt-Hour
Fuel	$3,607.38	$0.00597
Lubricating oil	576.00	.00095
Supplies and repairs	134.60	.0002
Labor	3,360.00	.0055
Total operating cost	$7,675.98	$0.0126
Fixed charges	977.00	.0082
Total costs per kilowatt-hour		$0.0208

While the fuel consumption may appear low for this type of engine, the data were obtained from the municipal records and should be correct.

Rewinding Direct-Current Armatures

By FRANK HUSKINSON



EXPLAINS the different operations in rewinding an armature, from stripping off the old winding and taking the winding data to making the armature ready for service again.

IN THE rewinding of an armature there are practically fifteen different steps or operations: Removing the old coils and checking up the connections; cleaning the core; cleaning the commutator; testing the commutator; reinsulating the core; putting in the coils and bottom leads; rotation test and putting in the top leads; trimming the slot insulation and putting in slot sticks, if used; soldering the leads in the commutator; removing surplus solder and testing the winding; placing insulating material over the coil ends, front and rear, and hoods, if used; banding; turning and slotting the commutator; balancing the armature; final testing and painting.

Assuming that the winding is one that the winder is not familiar with, it will be necessary to check up the connections. If the armature has no end bell or shield on the rear, measure the distance that the end of the winding projects beyond the end of the core; note the width of the bands, their location and size of band wire; note if there are any hoods or covering on either or both ends of the winding; count the number of slots in the core and the number of commutator bars; check up the connections by tracing a top lead from the commutator bar to the slot in the core, then line up the center of this slot with the center of a mica or commutator bar (see Fig. 1). Mark this bar and count from it to the bar the lead is connected to, and see if it is to the right or left when facing the commutator; this gives the top throw of the leads, Fig. 1. In some armatures the top leads will come out straight to the commutator and all the throw will be on the bottom leads, or vice-versa.

The next step is to locate the bottom lead of the coil being used to obtain the winding connection. There are two general ways of connecting armature windings —series and multiple. In a single multiple connection the two ends of a coil will be found in adjacent commutator bars as in Fig. 5. In the series connection it will depend upon the number of poles in the machine. In a four-pole motor the throw of the leads will be halfway around the commutator, as indicated in Figs. 3 and 4. In a six-pole motor the throw of the leads will be one-third of the commutator's circumference (see Fig. 2).

In order to check up the old winding connection, remove the top leads from the commutator, being sure to mark the top lead that is used to check the winding, also mark the bar to which the lead connects. Then, with a test lamp or bell locate the bottom lead of this coil, mark this bar No. 1 and count the bars back to and including the one to which the top lead was connected. This will give the connection or total throw of the leads on the commutator, as indicated in Fig. 1.

Check up the throw of the bottom leads in the same manner as the top leads were checked. The throw of the bottom leads is of even more importance than that for the top leads, inasmuch as the bottom leads and coils are all put in before any attention is given to the bottom leads. The latter will of course have to connect to the proper commutator bars to make the proper connection. The throw of the leads must be such that the brushes will rest on bars connected to conductors in the neutral region. Next, note the number of slots spanned by a coil; that is, the bottom of coil is in slot No. 1 and the top is in slot No. 2, and record the data on a diagram, as in Fig. 1. After having noted and marked down the proper throw of the leads, connections and coil span, the old winding may be removed from the armature.

Cleaning the Core and Commutator

In cleaning the core, all slots are filed out and all sharp corners, edges or burnt places are removed. All the old insulation and surplus paint is removed and an air blast used to blow out all dust, etc.

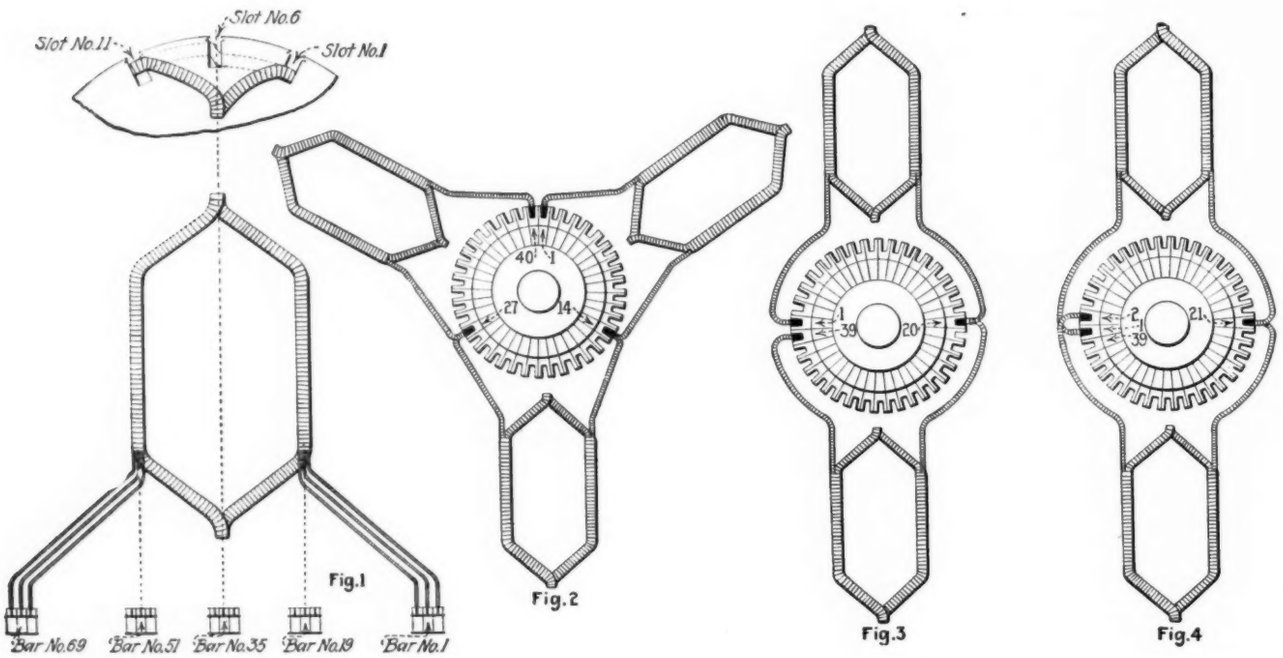
The commutator is cleaned and all slots for the leads are cleaned out and if necessary they are tinned. For cleaning out the slots for the leads in a commutator a convenient tool is an 8-in. hacksaw. If the commutator has been undercut, or slotted, the slots are all cleaned out with a piece of a hacksaw blade held in a suitable handle. The mica V-rings on both the back and front of the commutator are cleaned and given a coat or two of shellac, after which a layer or two of tape may be placed on the rings and a cord band wound over it. This band is then given a couple of coats of shellac varnish.

The commutator is given a thorough test for

grounded and short-circuited bars with a lamp and test circuit, and the bars should show that they are thoroughly insulated from each other and insulated from the V-rings.

If the armature core has an end bell or shield on the rear, this should be well insulated with friction tape, empire tape or asbestos tape and canvas. The neck of the armature between the end of the core and the commutator should also be well insulated. Shellac varnish is applied to the insulating material and on the ends of the core. Fish paper, oiled cambric or other suitable insulating material is cut to size to make insulating cells for each slot. The size, material, etc., of the insulating cell can be determined only by the size of the slot and coil. The slot insulation should be cut large enough to extend about three-quarters of an inch above the tops of the slots and about one-quarter inch beyond the ends.

In cold weather, or if the coils are difficult to shape on account of stiffness, heating them before putting them in the armature makes them more pliable, and there is less likelihood of damaging the insulation. If the coils are a tight fit or the outside insulation is rough, they may be properly shaped to size by pressing them in a vise. Rubbing the coils with a cake of paraffin is to be recommended in all cases. Ordinarily a rubber mallet with a 2-in. face and about a pound in weight is a handy tool when putting in the coils and shaping them up. Do not strike a coil with a hammer; always use a piece of fiber between the coil and hammer. Small steel bars with the ends covered with friction tape, or pieces of fiber shaped to hook over the coils may be used in forming them to shape. In tapping the coils into place in the slots, always use a piece of fiber that has been made slightly narrower than the coil.



Figs. 1 to 4—Lead throw on series winding

Fig. 1—Shows how to record armature winding data. Fig. 2—Connection for one series of coils around a six-pole armature winding connected series. Figs. 3 and 4—Two ways that the coils on a four-pole series winding may be connected.

After determining the proper coil and lead pitch from the diagram made when the armature was stripped, proceed to put in all the coils, keeping them shaped properly. As each coil is put in the slots, the bottom leads are connected to the commutator. The success of the winder depends largely upon the care he exercises in getting the first coils and leads properly placed and shaped. Care should be given to placing of the bottom leads; these should be brought to the commutator bars without any unnecessary kinks or bends and should lie close together and upon the insulation. As a rule there is just enough room on the neck of the armature for the leads to fit in snugly. If the work is started wrong or the leads are not kept snugly together, there will not be enough room for the last leads, which makes it necessary to pile them up at the finish. This results in an unsatisfactory job and increases the chances for trouble to occur at this point in the winding.

Rotation Test and Putting in the Top Leads

After the coils are in place and the bottom leads are connected to the commutator, wrap an uninsulated wire around the commutator so as to short-circuit all the bars. Then, with a lamp and test circuit test for grounds by connecting one lead to the commutator and the other to the armature core and shaft. Finding the coils clear, remove the short-circuiting wire, separate all the top leads, lay them back from the commutator in rotation and make a test for short-circuits between coils. First place one terminal of the lamp test-set on a commutator bar and mark this bar, then with the other test terminal touch the top leads until one is found where the lamp lights. This lead will be the other end of the coil that is connected to the bar on which the other test lead rests. Leaving the test terminal on the same commutator bar, touch the lead on each side of the one where the lamp lights; getting

no light from these leads indicates that the coil that the lamp lights on is O.K. If the lamp lights up on more than one lead at a time, it indicates that the leads are short-circuited together, or else there is a short-circuit between commutator bars. Make the test all the way around the commutator by moving the test terminal one commutator bar at a time and testing the top leads with the other test terminal until the lamp lights.

The top leads should test out in rotation; if they

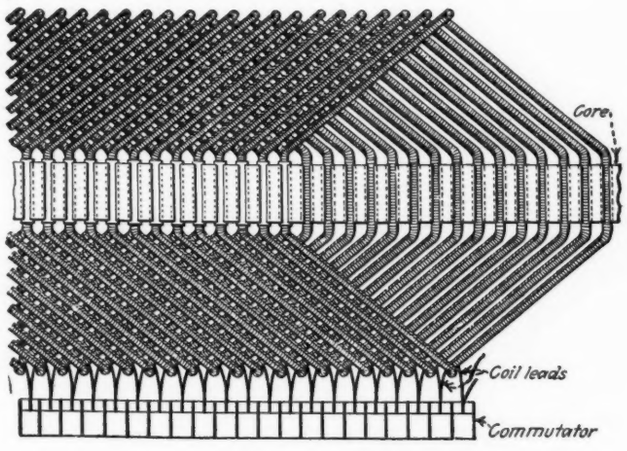


Fig. 5—Section of a parallel winding

do not there is probably a cross in the bottom leads, which should be removed. As the leads are tested, separate them and lay them out in rotation as they go in the commutator. Next, put the insulation over the bottom leads and coil ends and find the proper connection for the top leads, then proceed to put in the top leads all the way around the commutator. In some armatures the commutator bars are considerably lower than the tops of the coils, and this may necessitate putting the top leads in two layers to get a neat job. When it is found necessary to do this, put in every other lead all the way around the commutator, for a bottom layer of top leads. After this put in the remaining top leads and a neat looking job can be obtained. In an armature with the commutator bars or risers approximately the same height as the top of the coils, the top leads may be placed in a single layer. When all the top leads are in place, take a rubber mallet and a piece of fiber and proceed to shape up the ends of the coils and leads, after which cut off the lead ends that extend through the slots in commutator bars, with a sharp chisel and a hammer.

Trimming Slot Insulation and Putting in Slot Sticks

In cutting the slot insulation for the coils, the paper cells are left from one-half to an inch higher than the core as a guide in putting the coils in the slots. This insulation will have to be trimmed off flush with the core after the winding is in place. If slot sticks of wood or fiber are used, the edges of the insulation cells will have to be folded over on top of the coil and the slot stick put in. In many instances the slot insulation is cut off down in the slot flush with the top of the coil, before the slot sticks are put in place.

After all the leads are in the commutator bars, take friction tape and wind a couple of layers over the leads close up to the commutator bars; this is to protect the insulation on the leads and to prevent solder from getting into the leads while soldering. Block up the back of the armature so that the rear end is one or two inches higher than the commutator end, to prevent solder from running in back of the commutator bars and wires, thereby causing short-circuits. Use a good non-corrosive soldering paste on the leads and bars, and half-and-half solder.

A pair of four- or five-pound soldering irons with the tips shaped like a blunt cold chisel are best for soldering leads in a commutator. Before applying the soldering paste it is advisable to take a blow-torch and thoroughly warm up the commutator all the way around, being careful not to bring the torch close enough to injure the commutator. Use clean hot irons and make sure that each bar has the leads well sweated in. Use plenty of solder as this helps insure good connections and the surplus is easily cleaned off. Sal-ammoniac salts and some solder make an excellent cleaner for soldering irons. As soon as all the leads are soldered in, wash the commutator thoroughly with alcohol or gasoline to remove all traces of the soldering paste.

Removing the Surplus Solder and Testing Out the Winding

All the surplus solder should be removed after the leads have been soldered. A 12-in. babbitt file may be used for this purpose. After removing all surplus sol-

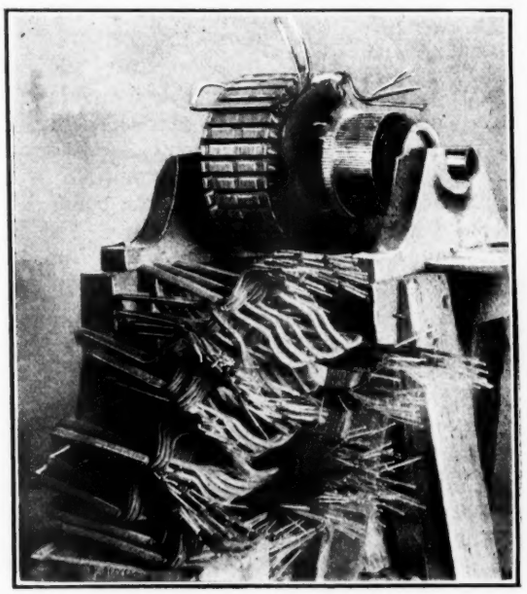


Fig. 6—Armature core ready for insulation after removing the winding

der from the risers, go over the commutator thoroughly and remove all traces of short-circuits. With the test lamp, make a test for grounds, then with a test set make a bar-to-bar test for open-circuits, short-circuits, poor connections and reversed leads.

After giving the armature the bar-to-bar test and finding the winding O.K., a coat of shellac is applied to the top and front of the commutator risers. Suitable insulating material is wound over the ends of the coils and leads, front and rear, and if the ends of the winding are protected with a light-weight canvas covering or hood, this is fitted over the ends.

If the core of the armature is recessed for bands, cut strips of thin mica to fit, holding these strips in place with a small wire. Where hoods are used, they are fastened under the end core bands. For the larger bands which go over the coil ends, mica cut in about 6-in. lengths and the proper width are placed in position and held in place with a small wire on the rear and front. Bands on the coil ends should be anchored to the end core bands. If this is not advisable, build up

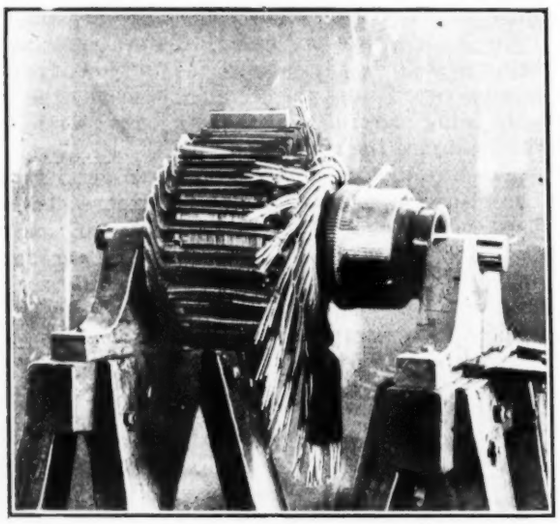


Fig. 7—Winding on armature and bottom leads connected to commutator

the insulation on the ends in such a manner as to have the outer edges of the bands higher than the center; that is, the band when wound on will be convex instead of flat, which will prevent it from slipping off.

After the insulating material for the bands is properly in place, copper clips are cut and spaced at regular intervals around the armature. These are slipped under the wires that hold the insulating strips in place. At the start and finish of a band place two clips close together and let the band wire start on one and finish on the other.

Putting on the Bands

With the banding insulation and clips in place the armature is put in a lathe, or if this is not advisable it is mounted on a suitable stand and a handle for turning it is fastened to one end of the armature shaft. The proper tension to use in banding an armature is a matter of judgment on the part of the winder, since this depends on the size and kind of band wire and size of armature, also the speed and service for which the motor is to be used. No. 16 or 18 steel band wire is used for the average medium-sized armatures. A steady tension should be maintained when applying the bands. The proper tension on the band wire can be obtained by using a friction block made of two pieces of wood or fiber. There are some advantages in using a friction block in banding. The friction caused by the band wire passing through the block tends to heat the wire and expand it. When the wire cools, it contracts, thereby making a tighter band. The friction also removes dirt and rust from the band wire and makes it easier to solder.

In banding always have the tension block about six or eight inches from the armature. The wire is wound on until the proper width of band is obtained, then the clips at the start and finish are bent over on the band wire and soldered in place. The wire is then continued on to the next band and so on until the banding is completed. Care should be taken to fasten and solder the ends of each band before starting to wind on the next one. After all the bands are in place the surplus wire is cut off and the clips are trimmed and bent over the band. Soldering paste or a solution of soldering salts is applied to the wire and clips and the bands are soldered all the way around, after which they should be washed off with alcohol or gasoline to remove all traces of the soldering compound.

Commutator Turning and Slotting

After banding and soldering, the commutator should be turned true in a lathe. If this is not necessary, thoroughly clean the face of the commutator with sandpaper, and if the mica is undercut it should be cleaned out and if necessary slightly undercut again.

Armatures, after rewinding, especially if for high-speed service, should be tested for balance. The armature is mounted on two horizontal rails as in Fig. 8, and if it shows a tendency to rotate from any but one position it is out of balance. A properly balanced armature will stay in any position and show no tendency to rotate on the rails.

The armature is now practically finished, but it is advisable to make the bar-to-bar test again, as previously referred to. Also the test for grounds. After making this final test the armature is ready for painting. If a suitable oven is at hand for baking the armature, use a good baking varnish. If no oven is available, the best paint to use will be a good air-drying varnish. A much better job is done with the air-drying

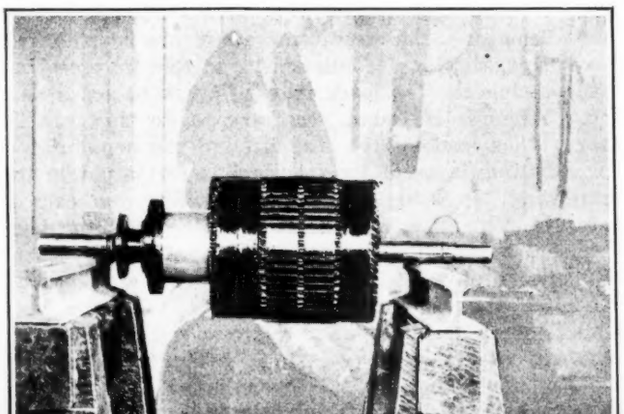


Fig. 8—Armature on balancing rails

varnish if it is applied hot. A second coat of varnish may be applied after allowing the first coat time to dry thoroughly. The armature will dry in a shorter period if it is kept in a warm dry place.

In the rewinding of any armature the success of the winder depends on getting started right. It is advisable to be careful, neat and particular from the start to the finish, never to get in a rush and start to slap the coils or connections in any careless way, as this does not produce satisfactory results.

Accuracy in High-Temperature Testing of Materials

By L. W. SPRING* and J. KANTER

SOME years ago the attention of designing engineers was called to the fact that the strictly correct method of designing would be to calculate safe loads from the elastic limit of a material, that is, the stress at which permanent deformation began, rather than from its ultimate or tensile strength.

It is evident that for purposes of design, a material may be considered useless after even a moderate amount of deformation. There is no question, however, that while this is so, the engineering world has so long calculated from the basis of tensile strength, that while it may not be scientifically correct, yet with the factors of safety allowed through long experience, the old method gives approximately correct results. Just so, while not based on actually determined strengths under operating conditions, the use of boiler, turbine, piping and valve materials under reasonable steam temperatures, say up to 600 to 750 deg. F., have been reasonably safe because of having been founded on long experience. Now, however, with the rapid increases in working pressures and temperatures, which bid fair to go to 1,200 or even 3,200 lb. pressure with temperatures of 750 deg. F. or higher, it is necessary that more accurate testing of steels at high temperatures be done than heretofore.

WITH the higher pressures and temperatures now prevailing in steam generation, there is necessity for greater accuracy in the testing of materials. Standardization of testing equipment and methods is in progress. The authors summarize the present status, comparing full-wound and gap-wound electric furnaces, temperature differences in the testing bar and inside vs. external contact for temperature readings. With the older full wound furnace and surface reading it is easily possible to overrate steel 25 per cent.

An important step has been taken in the formation and the work so far of the two high-temperature committees formed jointly by the A. S. M. E. and the A. S. T. M. The first of these brought forth the symposium on "Effect of Temperature Upon the Properties of Metals." The new committee, now existing, expects shortly to bring about co-operative short- and long-time high-temperature tests at various universities and industrial plants. This is expected to be the beginning of much more correct and useful high-temperature information than has been available.

Accurate determination of physical properties of materials at definite high temperatures is difficult, so that no conscientious and hard-working investigator should be blamed when later advance and refinement in the art of testing at high temperatures proves that his earlier results have been somewhat erroneous. Two of the major difficulties of high-temperature testing which bring about inaccuracies are lack of uniformity in heating the test bar and incorrect reading of its temperature.

Uniformity of temperature throughout the breaking section of the test bar is highly important, as also is accuracy in determining that temperature. If, for any reason, the temperature is read 100 deg. high, as easily is possible, the points of the curve, so read, are displaced just that far toward the high-temperature end of the graph, thus giving the material being tested a fictitiously high strength. This element alone may bring about an error well up toward 10,000 lb. per sq.in., as shown in Table I and Fig. 5. Our earlier high-temperature curves of many of the usual engineering cast and rolled materials which the market afforded were published in 1912, and almost continuous work with increase in accuracy in high-temperature testing has been done by us since that time. However, we now know that some of the earlier results were not quite so accurate as we then thought them. Inasmuch as the work has been of considerable magnitude and the result of much thought and conscientious experimentation to prove or disprove correctness, it is felt that our high-temperature results of late years are quite close to correct. They have lately been corroborated by three other recognized authorities, two of which are departments of the United States government.

Heating Furnaces—Of recent years, practically all furnaces are electric, the center consisting of some sort of a tube designed to inclose the bar being tested. This insulated tube is wound usually with resistance wire either continuously, or with a gap or by other means, with greater heating power on the ends. In some cases, for particularly high temperatures, other resistance material is used to produce the heating effect. Naturally, these furnaces vary in shape, size and construction.

Test Bars—Test bars have been of various lengths, usually threaded at both ends, to fit the specimen holders and with a 2-in. breaking section over which elongation is to be measured. In rolled materials, such as plate, longer sections at times have been used, the furnace being constructed for the purpose.

Temperature Taking—There have been two main methods of temperature taking used, one from inside the bar or at least beneath the skin, the other from some point on the exterior of the turned or breaking section by a thermocouple tied to or pushed against it.

Insulation of Bar Holders—When testing at 800, 1,000 or 1,200 deg. F. or more, a great amount of heat

*Chief chemist and metallurgist, Crane Company.

must be fed to the bar by the heating coil in order that the bar shall reach the desired temperature. Naturally, the greater the conduction or radiation of this heat, the more difficult it is to reach and maintain the proper temperature, also the more difficult to make sure of uniform temperature throughout the length of the bar.

Though it seems not to have been done by others, we have found it highly desirable that heat conductivity of the bar holders connecting with the upper and lower head of the machine be broken by inserting companion flanges which are insulated from each other by asbestos pads. Contact of metallic parts through which heat from the test bar can flow to the machine heads is fully prevented by insulation, even around the bolts that fasten the companion flanges together. The furnace and test bar are therefore insulated from the rest of the testing machine, making the heating of the bar quicker and aiding materially in uniform heat distribution throughout the bar.

Comparative Tests with Two Types of Furnaces—In Fig. 2 is shown the test bar, which is 7 in. long, threaded at both ends, with a $\frac{3}{16}$-in. diameter hole drilled axially from the top down to within $\frac{1}{4}$ in. of the top of the breaking section. This is of 2-in. length and turned to 0.505 in. diameter. In the same drawing is shown the heating coil or furnace, which, while simple,

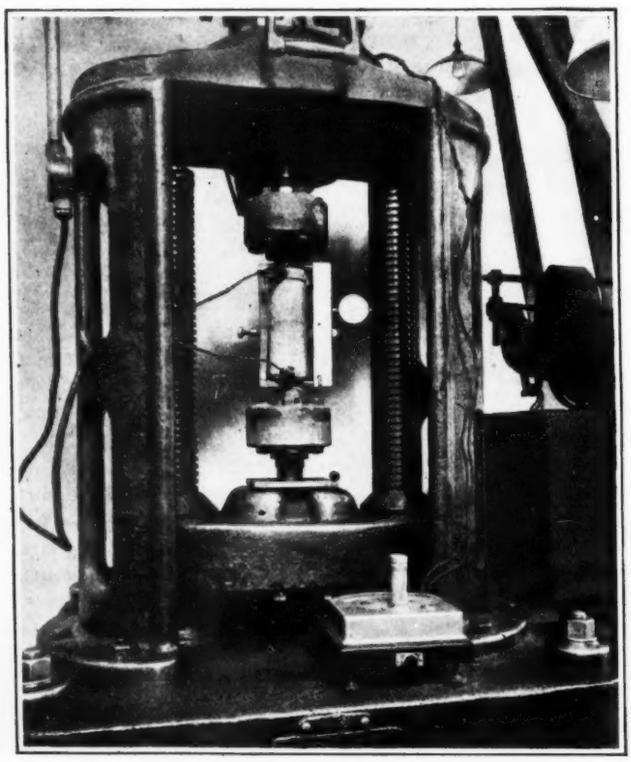


Fig. 1—Testing machine with bar, heating coil and measuring apparatus in place

has been found effective and accurate. This slides closely over the holders into which the bar ends thread. It consists of a light sheet-steel sleeve upon which is placed a thin layer of sheet asbestos for electric insulation only and then wound with nichrome wire.

It is evident that if the heating furnace is wound uniformly over its full length, the center of the coil will give proportionally greater heat than the ends. Therefore, the bar will be hottest at its breaking section, and a thoughtful person must question if the temperature over the entire 2-in. breaking length can be strictly uniform.

Instead of leaving the coil bare of resistance wire over a certain distance at the center, as we have done,

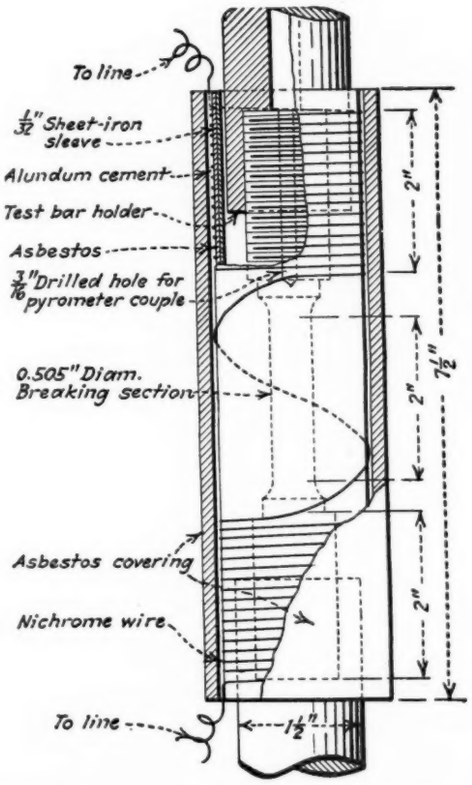


Fig. 2—Gap-wound heating coil and test bar

certain other investigators have wound resistance wire more closely at the ends than at the center to produce what they call a compensating coil, or have wound two layers of resistance wire over each end with but one layer only along the middle of the coil, thus producing much the same effect. Earlier coils were wound in a uniformly spaced manner, and some are so wound yet with the result shown in Table I.

In the accompanying tables are compared temperature readings determined simultaneously at different locations in the bar, using three carefully standardized thermocouples. These tables give direct comparison of the uniformities of heating the test bar. Table I gives results from the old-fashioned full-wound coil and Table II results from the gap-wound coil.

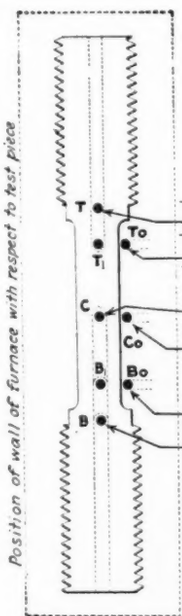
The results shown in the tables are "at equilibrium"; that is, the bar has come to the desired temperature and shown little temperature variation for ten minutes before readings were taken. Since from our earliest testing, temperatures have been read from inside the bar at point *T* as a standard, the current was so regulated as to bring this point to the desired temperature in all cases.

The Full Wound Furnace—It will be noticed in Table I that with the full-wound furnace the center of the length of the breaking section is always hotter than the ends and, particularly, that the temperature

readings taken from the outside or surface anywhere along the length are considerably higher than corresponding inside temperatures.

Gap-Wound Furnace—With the gap-wound furnace that we have used during recent years, the differences between the middle of the gage length *C* and the end *T* are cut from 20, 50 and 90 deg. to 0, 5 and 5 deg. at testing temperatures of 500, 750 and 1,000 deg. F. respectively (compare Tables I and II). Further, the differences between the temperatures of the surface center *Co* and the inside center *C* is reduced from 130, 130 and 90 deg. to 50, 35 and 20 deg. at the three temperatures mentioned. At any desired temperature up to and including 1,200 deg. F. there is not over 10 deg. difference between top, center and bottom along the interior or axis of the breaking section.

An important factor in the accuracy of temperature taking is the location of the thermocouple, owing to the difference in temperature between the exterior and interior fibers of the bar. Since the heat is applied on the outside, comparatively close to the surface, these outer fibers are hotter naturally than the interior of the bar, which must receive its heat after it comes to the outside. For this reason the taking of temperature by simply pushing a pyrometer tip against the exterior surface of the breaking section without shielding it in some way from the radiation effect of the interior of a full wound, non-compensating heating



Temperatures Desired

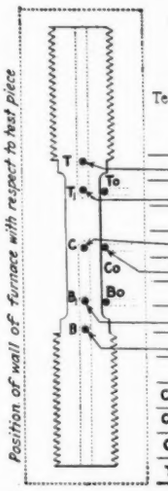
	70°	300°	500°	750°	1000°F
	Temperature Readings Obtained at Indicated Points				
T	70°F.	300°F.	500°F.	750°F.	1000°F.
To	70	335	565	845	1115
C	70	310	520	800	1090
Co	70	400	650	930	1180
Bo	70	335	555	840	1115
B	70	295	490	730	970
					Temperature excess
To > T	0	35	65	95	115 Outside top over inside top
Co > C	0	90	130	130	90 Outside center over inside center
Co > T	0	100	150	180	180 Outside center over inside top
C > T	0	10	20	50	90 Inside center over inside top

TABLE I—SIMULTANEOUS TEMPERATURE READINGS THROUGHOUT THE BREAKING SECTION OF TENSILE BAR WHEN HEATED WITH FULL-WOUND FURNACE, EQUILIBRIUM HAVING BEEN ESTABLISHED IN EACH CASE

furnace so close to it, results in a temperature reading of the surface of the bar which is not accurate, no matter how hard the tip presses it. This in considerable measure is due to the temperature of the atmosphere immediately adjacent to the tip, which, of course, because of this radiation effect, is higher than that of the bar itself.

With the gap coil the greatest amount of heat is received by the ends of the bar. Naturally, the breaking section must receive its heat from these ends, with a little heat also, directly from the unwired middle portion of the heating coil. This results in a quite uniformly heated breaking section, as has been shown.

Several experiments were undertaken to prove the effect of this radiation on a thermocouple tip pushed against the test bar instead of within it. A small crucible filled to the top with molten tin was placed in an upright cylindrical electric furnace (2x10 in. inside)



Temperatures Desired

	70°	300°	500°	750°	1000°	1200°F.
	Temperature Readings Obtained at Indicated Points					
T	70°F.	300°F.	500°F.	750°F.	1000°F.	1200°F.
T_i	70	300	505	755	1005	1205
C	70	300	500	755	1005	1205
Co	70	340	550	790	1025	1200
B_i	70	300	500	755	1000	1210
B	70	310	490	745	995	1200
Co > C	0	40	50	35	20	-5 Outside center over inside center
Co > T	0	40	50	40	25	0 Outside center over inside top
C > T	0	0	0	5	5	5 Inside center over inside top
T > B	0	-10	10	5	5	0 Inside top over inside bottom

TABLE II—SIMULTANEOUS TEMPERATURE READINGS THROUGHOUT THE BREAKING SECTION OF TENSILE BAR WHEN HEATED WITH GAP-WOUND FURNACE, EQUILIBRIUM HAVING BEEN ESTABLISHED IN EACH CASE

and allowed to reach equilibrium at 600 deg. F., as shown by a thermocouple tip ¼ in. above the surface of the metal, but in line for some radiation from the furnace wall. Then lowering the tip until it was just covered by the tin, the tin temperature indicated was 540 deg. F., or 60 deg. F. lower than that just above the surface. A second experiment, placing a copper-foil radiation shield around the crucible, thus shielding the thermocouple, crucible and its contents, decreased the difference at equilibrium to 15 deg. F., at 600 deg. F.

Thus having shown that radiation from the walls of the furnace influences external temperature recording, it remained to show what happens when air-to-liquid contact is made internally under the conditions that exist in the thermocouple well of tensile specimens for high temperatures. A brass bar of 1 in. diameter was suspended in the furnace under the same conditions as in the crucible experiment. A small quantity of molten tin about ¼ in. deep, was placed in the $\frac{3}{16}$-in. diameter hole drilled 3 in. deep in the end of the bar. With a thermocouple tip placed only ¼ in. above the surface of the molten tin, an equilibrium reading of 600 deg. F. was again attained, upon which the tip was immersed, showing an actual temperature in the tin of 605 deg. F., a 5-deg. F. increase.

This appears to indicate that liquid contact is not essential when couples are placed internally, since the air pocket surrounding the tip receives its heat through the metal instead of by direct radiation from the furnace wall. In practice the thermocouple rests on the bottom of the hole and therefore has actual contact with the test bar.

The foregoing emphasizes the necessity of placing thermocouples internally for accurate high-temperature

testing. Taking surface temperatures might be fairly accurate if firm contact of tip can be assured by strapping or, better, by welding, but it cannot be accurate when the thermocouple tip is merely pressed against the bar. Welding the thermocouple against the surface was found by one investigator to lower the temperature readings by 25 to 45 deg. F. from those indicated by pressure only, and we found that less secure surface contact of a couple brought about by thinning of the test bar during pulling raised the temperature reading from 600 to 640 deg. F. What temperature reading, then, shall an incautious operator use, the first one or that registered at the moment the bar breaks?

Strictly speaking, some sort of composite or average of interior and exterior temperature readings might be made, to be as nearly accurate as possible, since the exterior of the bar is hotter and the majority of the cross-sectional area is nearer the exterior than the interior. For this reason, for greatest accuracy, temperatures should be read somewhere between surface and center. However, since with a gap-wound coil the greatest difference between the surface reading at the center of the length *Co* and the inside of the bar at the top end of the breaking section *T*, is not more than 50 deg. F., and since from the viewpoint of engineering safety it is better to underrate than to overrate the strength of a material, temperature readings from

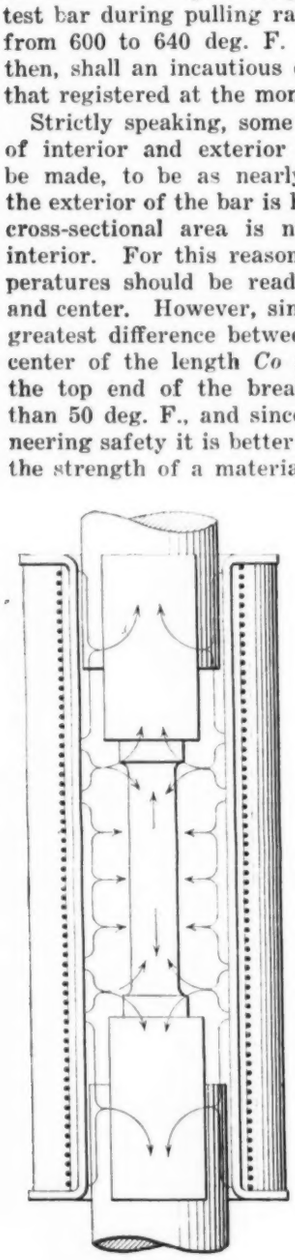


Fig. 3—Full-wound furnace

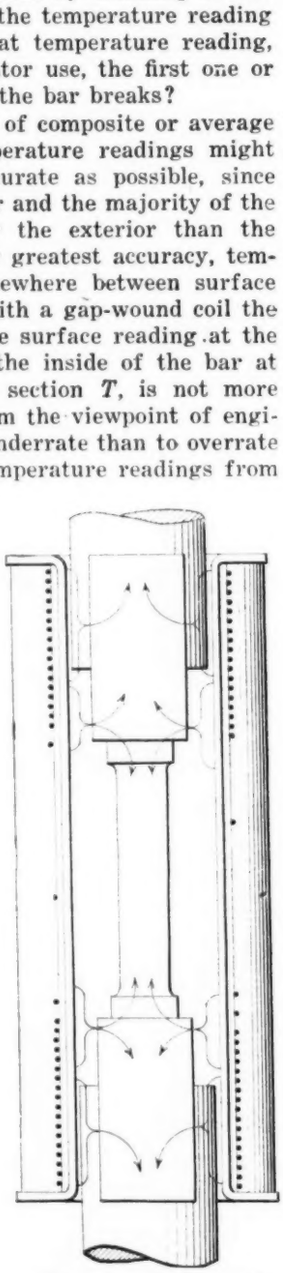


Fig. 4—Gap-wound furnace

Sketches indicate main heat radiation and travel from coils

point *T* is not an unwise choice, even though an inside point halfway nearer the surface might be slightly more correct theoretically.

Actual results on duplicate sets of carbon cast-steel test bars pulled side by side in the same manner in the gap-wound furnace and in such a full-wound furnace as one described recently in the literature of High Temperature Testing, are given in Table III and the curves of Fig. 5. The apparatus shown in Figs. 1 and 2, including the light helical springs which keep the breaking section of the test bar central with the furnace length while pulling, and the temperature read from inside the bar, was used for the lower strength curve, which is the more correct one.

It will be noticed that the combination of surface

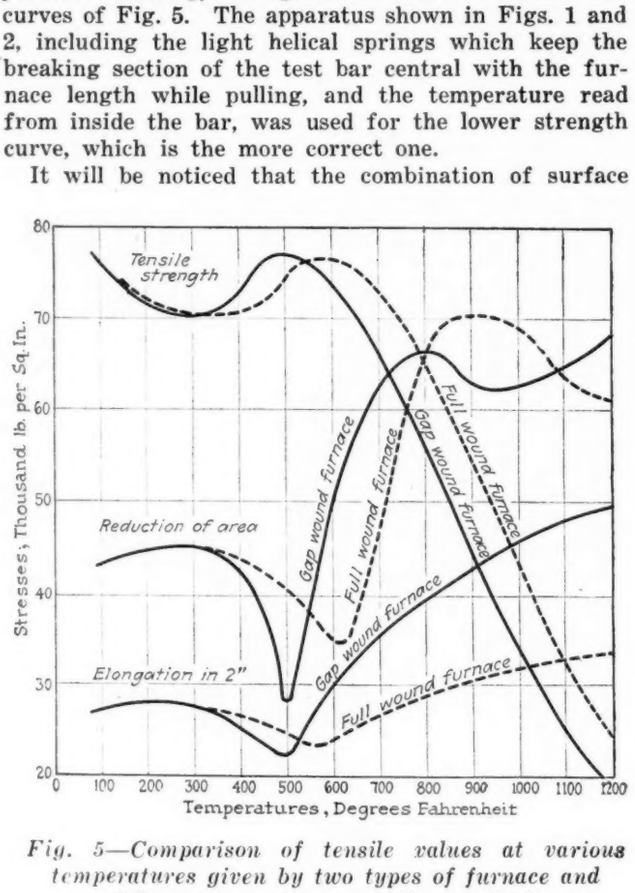


Fig. 5—Comparison of tensile values at various temperatures given by two types of furnace and different temperature reading methods

temperature reading and full wound furnace gives tensile strengths from 8,000 to 10,000 lb. high between 700 and 1,100 deg. F., thus overrating the steel from 13 per cent at 700 deg. F. to 24 per cent at 900 deg. F.

Besides the two major difficulties in high-temperature testing, which have been discussed as bringing about inaccuracies, namely, lack of uniformity in heating and incorrect reading of the temperature, there are others of somewhat lesser importance which must not be overlooked. All refinements are necessary for successful and accurate work.

To avoid the possibility of influence on results, the time that the test piece is under heat should be kept reasonably uniform.

The "speed of loading" (rate of pulling the bar in the tensile machine) influences the results, the strength being higher when the speed of loading is increased than when at a slower rate.

Mechanical difficulties of taking the elastic limit, the proportional limit or yield point of the material, bring about dissimilar results between different investigators.

These and other difficulties militate against accurate high-temperature testing, and it is not to be wondered at that results from different investigators have not been uniform. Fortunately, tests have shown that induction, due to the electric current passing through the heating coil, does not affect the mechanical properties of the material being tested.

Returning to the commercial aspect, within the last few months there appeared in these pages a short discussion concerning materials for use with high-

temperature steam. The fact was brought out that considerably greater economies in power-plant operation could be secured were there available materials for construction of boilers, piping, valves and turbines which did not suffer so severely at higher temperatures. By common consent 750 deg. F. has been considered the present temperature limit for such operation. A temperature of 1,000 deg. F. was mentioned as one at which greater efficiency would be obtained were the power-plant materials adequate.

This is exactly the idea that manufacturers of valves and fittings and power-producing apparatus have in view, and the indication is that it will not be long before more adequate materials will be forthcoming. While these may not have the flat trajectory or horizontal high-temperature curve suggested, such, of course, being most desirable, presumably they will be of a somewhat flatter type than those now commonly used. Reduction of the steep decline of the present tensile-strength and proportional-limit curves at temperatures above the 550 or 600 deg. Fahrenheit peak, will be most reassuring.

TABLE III—COMPARATIVE DATA FROM TWO TYPES OF FURNACE AND TWO METHODS OF READING

	Tensile Strength, Lb. per Sq.In.		Per Cent Elongation, in 2 In.		Per Cent Reduction of Area	
Deg. F.	Gap Wound Coil Inside Temp. Measurement	Full Wound Coil Surface Temp. Measurement	Gap Wound Coil Inside Temp. Measurement	Full Wound Coil Surface Temp. Measurement	Gap Wound Coil Inside Temp. Measurement	Full Wound Coil Surface Temp. Measurement
70	77,850	77,850	27.0	27.0	42.5	42.5
300	70,500	.....	27.5	....	44.9	....
450	76,500	70,950	24.0	20.0	37.9	37.3
500	77,100	75,800	21.5	24.0	27.2	40.7
550	76,150	76,500	26.0	25.0	37.9	38.5
600	74,450	76,600	30.0	23.0	50.5	34.8
700	65,750	74,300	56.0	27.0	62.8	46.8
800	55,700	.....	38.5	28.5	67.0	70.0
900	43,600	54,400	43.0	30.0	62.5	70.9
1,000	34,400	43,450	46.0	30.5	63.7	70.2
1,100	.....	29,650	....	38.5	....	63.6
1,200	18,700	25,850	50.0	33.5	68.2	61.4

At present our much higher strength alloy cast steel, our tempered alloy steel bolting, non-rusting and difficultly scouring seating metals (300 Brinell hardness) have put the curves high enough that without the flat trajectory there is residual strength enough left at 1,000 deg. F. and even at 1,200 deg. F. to be fairly satisfactory.

Though occasionally we have testimony of our regular carbon-steel pipe, valves and fittings, working on high-temperature, high-pressure lines so hot that they give off color at night, one could not advocate such practice. While on legitimate operation there is yet a good factor of safety in a well-designed steam valve made of carbon electric cast steel, the newer and stronger materials are now here to take their turn until the yet better materials arrive.

Concrete oil tanks are more susceptible to deterioration than metal tanks if there is any defect in the preparation of the cement as well as in the selection of the ingredients for the concrete and their mixing and pouring. The two most important features of design are the foundation and the reinforcing steel. Concrete tanks shall therefore be built only after detailed plans and specifications prepared by an engineer specially experienced in concrete tank construction have been approved by the inspection department having jurisdiction. Furthermore, it is essential that the construction work be entrusted only to thoroughly competent concerns.

Checking Turbine Efficiency by Means of Stage Pressures*

By M. K. Drewry†

Maintaining the efficient operation of turbines entails either periodic testing or continuous observation supplemented by occasional testing. Stage pressures and temperatures are an index to efficiency, and if carefully watched may furnish an immediate indication of internal trouble. To detect change in steam passage through any stage, which change might be caused by clogging of foreign matter, loss of blading, or bending of nozzle walls, the use of a "nozzle coefficient" is expedient and accurate. This arithmetical constant is derived as follows:

Each Stage a Steam Meter

Each stage of a turbine, or the entire turbine itself, may be thought of as a large steam meter. Once calibrate it by weighing the steam passed through it at a given initial pressure and temperature, and the amount of steam passed at any future time, even under different initial steam conditions, will be known with accuracy, from which the water rate may be figured. In the original calibration with the weighing tanks and test meters, K of the following formula will be solved:

$$\textit{Steam passed, lb. per hour} = K\sqrt{\frac{P}{V}}$$

where P and V are the absolute pressure and specific volume of the steam at the nozzle entrance, respectively. At any time later K may be used with accuracy for any moderate change of pressure or volume. Generally two constants, one for the first stage and one for the overload stage can be determined for later use.

To obtain the specific volume for use in the formula, temperature measurements must be taken, a difficult problem between stages of the impulse type turbine if accurate absolute values are desired. Adiabatic compression of the steam against the temperature indicator, because of the high velocities employed, gives a high reading, but since merely comparable values are desired from time to time for use in the nozzle coefficient formula, this consideration may be neglected. In attempting to determine the turbine efficiency by thermometer or thermocouple, however, unqualified reliance cannot be placed on temperature measurements in turbines.

Stage Pressure and Load Readings an Approximate Check

If only an approximate, easily applied check on the internal conditions of turbines is desired, the possession of a set of pressure readings taken initially when the machine is put into service, is sufficient. These pressures may be easily plotted against load, the two values being related by a straight line function, and at any future time will form a basis for judgment of the machines efficiency. If superheat and vacuum conditions vary considerably from the values at which the original readings were taken, the curve must be used with proper corrections of course.

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*Extract from a paper, "Steam Turbine Technics," which won a prize in a contest conducted by the Technical League, an organization of those connected with the company to which the author is attached.

†Technical engineer of Power Plants, the Milwaukee Electric Railway & Light Co.

Remote-Control Hydro-Electric Plant Operates on Old Canals of Holyoke

REMOTE and automatic control of hydro-electric stations have passed the experimental stage, and there are a considerable number of such installations in the United States at the present time. The purpose of such control being to avoid the necessity of maintaining an operating force continuously at the station, it is only natural that most such installations have been made in out-of-the-way places, somewhat distant from large centers of population. So it is a matter of some interest that the Holyoke Water Power Co. (Holyoke, Mass.) found it advisable to construct a remote-controlled hydro-electric plant on the old power canals in the heart of the city.

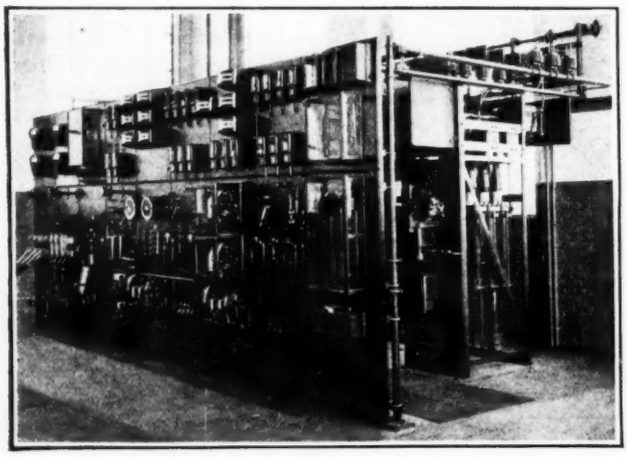


Fig. 1—This remote-controlled switchboard in plant No. 2 automatically starts, stops, speeds up or slows down any unit in accordance with signals received from plant No. 1

Before giving a brief description of this station, which has been in operation since the first of the year, it will be well to get a general picture of the power situation in Holyoke.

The sale of power to small consumers is from a municipally operated steam plant. All the water-power resources of the city are under the control of the Holyoke Water Power Co., which sells water to the paper and other mills, and also hydraulically generates a certain amount of electricity for sale in blocks exceeding 100 hp. for industrial purposes.

There are three levels of parallel power canals, all built many years ago. The upper level, taking water directly from the river above the dam, has a normal elevation of 100 ft. For the second and third canals the normal levels are 80 ft. and 67.5 ft. respectively. The third-level canal discharges to the river at a normal elevation of about 45 ft., giving a total fall throughout the system of 55 ft. The total flow through the canal system varies from about 12,000 cu.ft. per sec. maximum down to 2,500 in the dry months. There is practically no storage.

Some of the Holyoke mills take water from the first canal, discharging to the second, others utilize the fall from the second canal to the third, from the third canal to the river, etc., while still other mills discharge from the first or second canals direct to the river.

Power station No. 1 of the Holyoke Water Power Co., operating between the second level and the lower river, contains a total of 4,500 kw. in hydraulic units and 13,500 kw. in steam. This plant began operation in 1905.

In 1921 was built the first section of No. 2 hydro-electric plant, containing a single 500-kw. automatic unit. This, by the way, was the first automatic hydro-electric station in New England. Beside this small plant was a spillway from the first-level canal to the second. By 1924 the load had increased so much that a great deal of water was being fed to the second-level canal through this spillway for the purpose of balancing the canal system. To salvage this loss, the plant was enlarged to its present size. At the same time remote control of No. 2 plant from No. 1 was established, the enlarged No. 2 plant going into operation about the first of 1925.

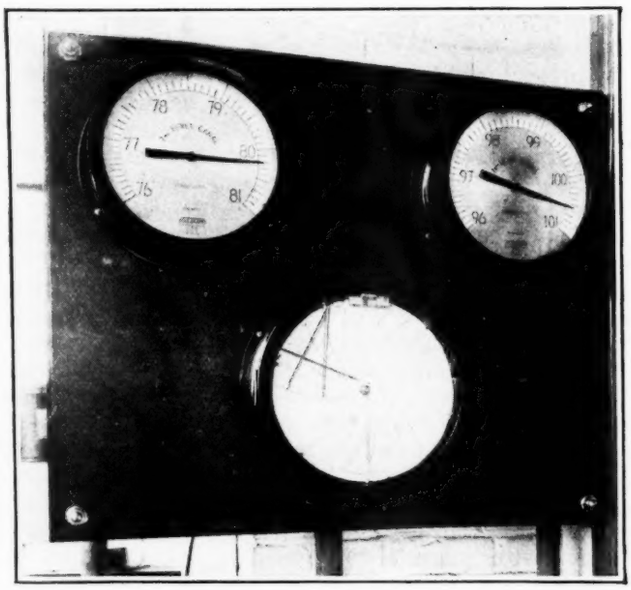
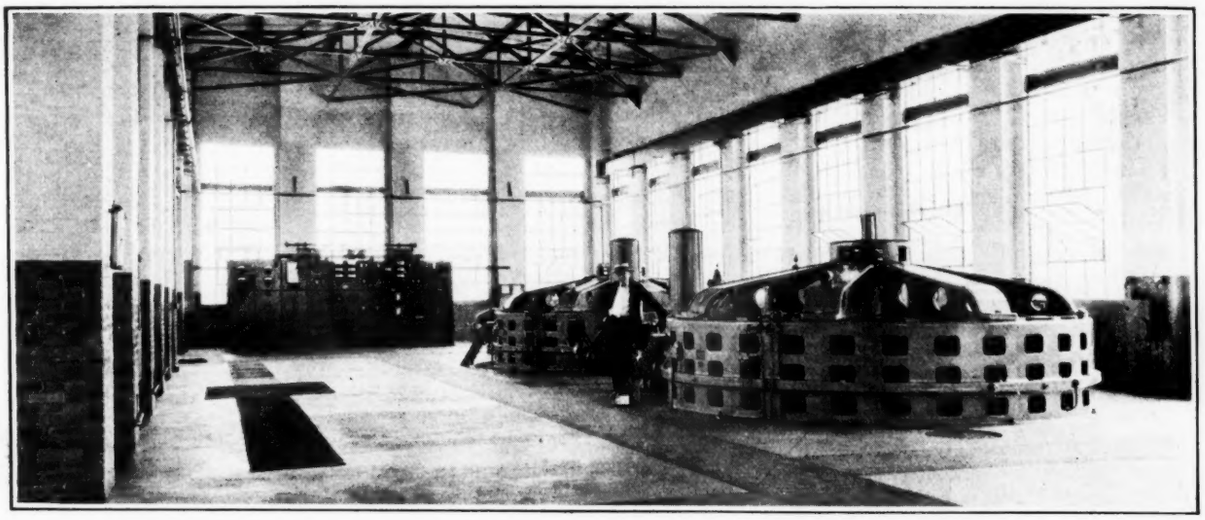


Fig. 2—Indicating and recording instruments show water levels in first- and second-level canals

The new station[1] operates at 6,600 volts three phase 60 cycles. The old 500-kw. unit has a type Z Leffel wheel of the high-speed Francis type. The two new units are alike, each being of 1,200 kw., and operating at 105 r.p.m. Their S. Morgan Smith type U Francis wheels are 62.5 in. in diameter. The over-all efficiency of the entire installation at best load is about 86.4

[1]The original 1921 installation in the No. 2 station was so small in comparison with the recent addition that this is in effect a new station.



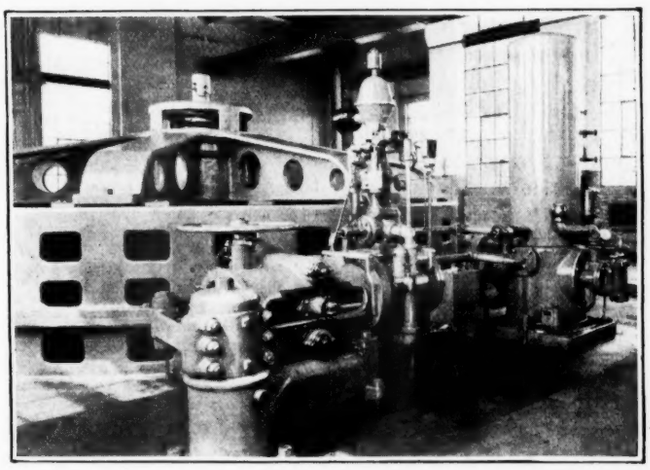
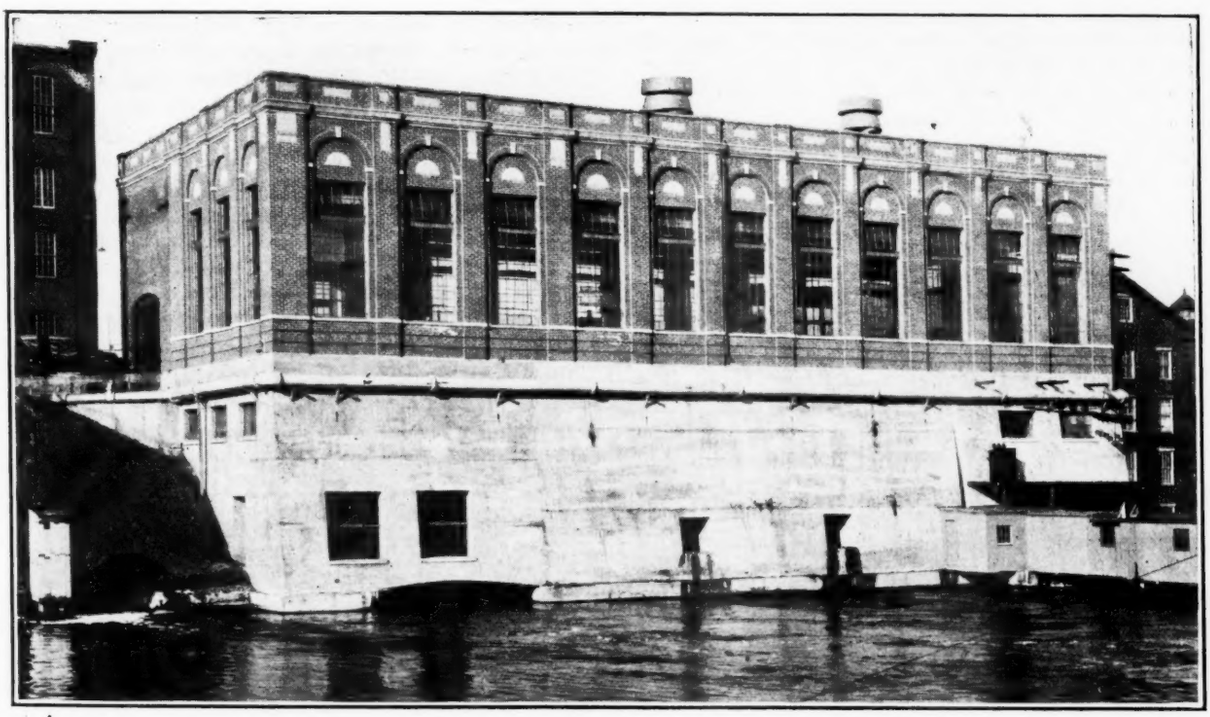


Fig. 3 (Above)—These two 1,200-kw. generators have 62.5-in. Francis-type wheels operating at 105 r.p.m. under a 20-ft. head

Fig. 4 (Right)—Governing mechanism can be remote-controlled through automatic switchboard

Fig. 5 (Below)—General view of plant showing the second-level canal in foreground



per cent, the generator efficiency being 96 per cent and that of the wheels 90 per cent.

A 7-wire control cable, covering the two miles between plants Nos. 1 and 2 enables all power-generating operations at No. 2 to be controlled from No. 1. To start or stop any of the three machines or to raise or lower their speeds, the operator at No. 1 station merely turns a dial (similar in appearance to a radio dial) to the proper operation, which then takes place automatically at the other station. Provision is made for a time lag, so that in turning the dial at normal speed from one operation to another, the operations marked at intermediate points will not take place.

Full automatic protection makes it practically impossible to operate the system so as to do any damage. There has been no trouble whatever up to the present time. An inspector from No. 1 plant calls at No. 2 about once a week.

At the present time one man stays at No. 2 plant, but ordinarily has nothing to do with the operation of power-generating machinery. His job is to operate the spillway gate from the first level to the second level in case the plant cannot take enough water to maintain the level in the second canal.

Although the plant is normally remote controlled, it is possible for the hydraulic attendant, by turning a speed-adjusting screw on the waterwheel governors, to control the amount of water passing through the automatic station and thus keep the second-level canal properly balanced.

Indicators at No. 2 plant give the level in the first and second canals, and an indicator at the office about a quarter of a mile away shows the river level. The necessary instructions are given by telephone. It is probable that remote control will be applied to these operations in the near future.

The design and construction of this station was handled by the staff of the Holyoke Water Co., of which Robert E. Barrett is president and treasurer, and Ralph A. Smith, civil engineer. The installation cost was in the neighborhood of $100 per kilowatt, in which connection it should be remembered that the dam and canals were already in place.

During the first six months of 1925, 3,300,000 kw.-hr. was generated from water that was formerly wasted.

"Functions" in the Power Plant

Kicking around in the mathematician's tool box are many little instruments capable of extensive usefulness in practical every-day life. One of the smallest, and at the same time one of the most potent, is the fundamental idea represented by the single word "function."

When the mathematician says that one thing is a "function" of another, he does not use the term in the same sense as does the doctor who says that breathing is a function of the lungs. Rather does he mean that the first thing mentioned depends on the second and on that alone. Picture a pieceworker in a machine shop performing a single operation at a definite unchangeable rate per piece. Eliminate the possibility of penalties for spoiled work. Then one may properly say that the worker's wage is a function of his output, since it depends on that and on nothing else. Just how the two are related makes no difference as long as the relation is definite. For example, the worker might get ten cents apiece for the first fifty and eight cents apiece for all beyond that number. His wage would still be a function of his output because there would be but one possible wage for any given output. If, in addition, there were a panelty for spoiled work, his wage would then be a function of his output and the number of pieces spoiled, since these two taken together would absolutely determine his wage.

But why all this excitement about a simple word? The worker, at least, can figure his wages just as well without it. The reason is that "function," an absurdly simple idea, is perhaps the most important in all science (including engineering) and as such needs a simple tag. When one finds out what depends on what in any practical problem, one is close to the root of the matter. The engineer who is always looking for functions in the things about him finds them, and when he finds them he soon gets results.

Take steam for example. The temperature of saturated steam is a function of the pressure. It depends on the pressure and on nothing else. Knowing this, one has at once added to one's practical engineering equipment the knowledge that one can measure the pressure of saturated steam with a thermometer or its temperature with a steam gage. Again, with a given set-up of pipe fittings, orifices and other resistances, and a given back pressure, the pressure at a given point in the line is a function of the rate of flow of water expressed in cubic feet per second, pounds per hour or any other way one pleases. When this fundamental fact has been grasped, one is prepared to measure water flow with a pressure gage. Nothing more need be known about hydraulic laws or formulas if one has a tank and stop watch with which to make a calibration curve showing how the flow varies with the gage reading for the particular set-up. The gage may even read incorrectly without affecting the result.

For a given barrel with a given hole drilled in the bottom, the flow of water is a function of the depth. Calibrate such a barrel by a simple test and it at once becomes a water meter. If any water discharge is to be measured, allow it to run into the barrel until the level is steady. Read the depth with a yardstick, then take a glance at the calibration curve and you have the desired rate of flow.

For a Corliss engine running at practically constant speed with constant throttle and exhaust pressures, the power is a function of the cutoff, which in turn is a function of the governor position. It follows that the power is a function of the governor position. The practical conclusion is that, with the aforementioned fixed conditions, a scale may be prepared on which some sliding part of the governor will indicate power directly.

Illustrations might be multiplied indefinitely, but enough have been given to show that the idea of "function," long the pet of the highbrow mathematicians, will more than earn its keep in the practical world.

Another way to find leaks in a condenser besides hunting for them with a candle flame, is to fill the condenser with water of 180 deg. F. and watch for the drops.

Ball and roller bearings are more compact than sleeve bearings. Motors so equipped are 15 to 20 per cent shorter in over-all length than motors having sleeve bearings.

EDITORIALS

F. R. LOW, EDITOR

Engineers in Public Positions

THE recent resolution of the American Engineering Council urging that public positions and offices requiring technical training and experience be filled only with technically qualified persons, while almost axiomatic, is one that cannot be pressed too strongly. It is possible that the Council may be able to exert some influence as pertains to appointive federal positions, but it is in connection with state and municipal positions that the big opportunity exists. Only through concerted action on the part of local engineering bodies, supplemented by greater activity in civic affairs by the members individually, can these aims be attained.

It is true that almost impenetrable barriers exist in most places in the form of a long-established political system, yet at times these have been broken through and the results have justified the effort. If the Engineering Council, through its participating societies, can awaken such local interest, it will have scored another point to justify its existence.

Nailing Down Boiler Performance

AN AUTOMOBILE manufacturer may—with reasonable safety—guarantee his product to attain a certain speed on a first-class level road. The old-time carriage maker could not do as much, since he did not sell a horse with each "buggy."

The boiler manufacturer's position is analogous to that of the carriage maker. His product must be hitched up with stokers, settings, stacks, etc., furnished by other companies. Yet, though in reality responsible for but part of the process, he is frequently asked for an over-all guarantee of performance from coal to steam.

Some fair and simple method of dividing up the responsibility would be a blessing to manufacturers and users alike. The essence of the problem is to devise some simple method of separating the performance of the boiler proper from that of stoker, furnace, etc.

Now give the imagination free reign for a moment. Picture a street on Mars. For some peculiar reason the inhabitants prefer to distribute energy through mains in the form of very hot non-inflammable gases (furnace gases, if you please). Manufacturers who need steam, pipe the hot gases to boilers in their plants. Don't worry about the transmission difficulties in this fanciful scheme. The point is that in such a case the boiler performance would be capable of definite expression in terms of gas consumption and heat content (above boiler-water temperature), the quantity of steam produced and the heat supplied to each pound.

Getting back to earth again, this method of defining boiler performance has recently been advocated by W. H. Jacobi in a paper presented before the Boiler Manufacturers' Association and abstracted in the August 25 issue of *Power*. Mr. Jacobi's suggestion is undoubtedly worthy of serious consideration. Broadly speaking, it may be said that the boiler's raw material is hot gas from the furnace, and its product steam. Given the weight per hour and the heat content of the hot gas supplied to the boiler, cannot the manufacturer guarantee a certain corresponding output regardless of the kind of stoker, furnace, fuel or the quality of attendance? It would seem so except for one thing. Not all the heat absorbed by the furnace comes from that in the entering gases. A portion of the heat absorbed—in some cases a large percentage of the total—comes directly by radiation from the fuel bed or hot furnace walls. If the performance were guaranteed solely on the basis of the quantity and heat content of the furnace gases, any radiant heat would constitute a sort of bonus of which account would have to be taken in one way or another. If Mr. Jacobi can suggest some practicable method of taking account of radiation, he will have rounded out a suggestion of considerable promise.

The Explosion on the "Mackinac"

ALTHOUGH the number of boilers exploding annually in the United States has been steadily increasing from 373 in 1900 to 751 in 1923, the attendant destructiveness and loss of life in each instance have diminished, and not since the Brockton explosion of 1905, in which 58 were killed and 117 injured, have we before been called upon to chronicle an explosion of catastrophic character such as that which occurred on the excursion steamer "Mackinac" on Tuesday, August 18, just outside of Newport, R. I.

To many of the older generation this will recall a parallel in the ferryboat "Westfield" disaster, which occurred in New York Harbor July 30, 1871, killing fifty outright and scalding over a hundred more, many of whom died from their injuries. As in the present case the boat was only slightly injured.

Investigations by the Board of Supervising Inspectors and the Attorney General of Rhode Island are in progress as this is written. From the testimony so far available it appears that the boat had been delayed in starting from Pawtucket in the morning by trouble with the boiler. Her departure from Newport on the return trip in the afternoon was delayed by a continuance of the trouble. She left Newport half an hour late, but had gone only about four miles when a circulating drum connecting the two water legs burst, as shown on page 307 of *Power* of last week, releasing a volume of steam and hot water which filled the interior of the boat and scalded the confined passengers so badly that fifty or more have died and many others are seriously injured.

The drum, which was twelve inches in diameter, had wasted away where the break occurred along the longitudinal seam from an original thickness of about one-

quarter inch to one-sixteenth. Leakage at this point was what occasioned the delay. The engineer called in a welder, but the latter was unable to do anything with it and the boat proceeded to Newport with only the other boiler in service. Just what was done during the stay at Newport to stop the leak has not appeared, but the start was made for Pawtucket with both boilers in service at the reduced pressure of 100 lb. under which pressure the break occurred.

The boiler had been inspected by a United States Inspector at New York in April, having been subjected to both a hydrostatic and a hammer test, according to the testimony of the inspector. It was accordingly allowed a pressure of 142 pounds. The corrosion was internal and would not have been apparent from the outside, nor was there any access to the interior. One-sixteenth of an inch of sound metal would sustain in a drum of this small diameter, a pressure of some six hundred pounds. If the inspection had consisted simply of a hydrostatic test to fifty per cent in excess of the allowed pressure required by the rules, the boiler might have easily got by. If, however, a condition of this seriousness can escape a skillful application of the testing hammer and present no evidences of distress under pressure, we have reason to feel concerned as to the adequacy of the usual means for detecting hidden faults.

It is to be supposed that the engineer had, during the day at Newport, done his best to make the leak tight and took a chance on its holding under the reduced pressure. It is apparent, of course, that he should not have fired the boiler. Perhaps he did not attach enough importance to the leak as a signal of distress and was more concerned about keeping his boiler usable and completing the trip.

A leak, especially around a longitudinal seam, is a call for help that should not be ignored, but followed out and not relinquished until the cause is definitely determined not to involve serious stress or deterioration. If the trouble had been reported to the federal inspectors before welding was attempted, as the rules require, the seriousness of the condition might have been discovered.

The finding of the investigators will be watched for with interest. Public confidence in the equipment of passenger vessels, the men who run them and the department that supervises their condition and operation must continue to be warranted.

European Versus American Steam-Turbine Efficiencies

JUDGING from opinions sometimes expressed off-hand, it would appear that turbines of medium capacity in this country suffer when compared with the highly efficient twenty-four hundred kilowatt machine installed abroad and tested by no less an authority than Dr. A. Stodola. In operation the Rankine efficiency ratio, referring to work at the coupling and steam conditions at the throttle was eighty-two per cent and that of the entire unit seventy-seven and nine-tenths. A description of this unit, with the test figures, appeared in the September 23, 1924, issue.

It must be realized, however, that results obtained by this particular machine do not represent average practice abroad. In his report of the test Doctor Stodola spoke of this in the light of a novelty for non-condensing efficiency, while published data on various European makes of condensing turbines indicate from sixty-six to seventy-two per cent as about the range of over-all unit efficiencies around this capacity. Incidentally, American built machines as variously reported do not appear to occupy an inferior position in this respect.

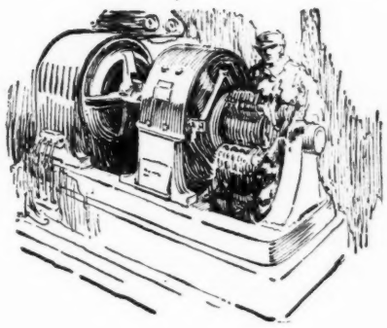
Assuming that the aforesaid turbine is above the average of its class, the question arises as what machines exist in this country with which it can be compared. Considering turbines from two to six thousand kilowatt capacity as in one class, it can be pointed out that a five thousand kilowatt back-pressure reaction turbine at comparatively low superheat tested in operation as high as eighty-five per cent coupling efficiency or eighty for the unit taking the generator at ninety-five per cent. Also, as pointed out by Dr. S. A. Moss in the May 19, 1925, issue, condensing impulse turbines of this capacity range could be built in excess of eighty-two per cent coupling efficiency with a sufficient number of stages. This design principle was proposed about twelve years ago and has been demonstrated by actual machines of around three thousand kilowatts before the aforementioned European turbine was constructed. In fact there are now, not one, but several American turbines in commercial operation comparable with the European unit in capacity and efficiency.

Superheat, as is well known, decreases the internal losses of steam turbines. Tests show that each one hundred degrees Farenheit raises the efficiency at saturation from one to three per cent over that with zero superheat. The European machine's over-all efficiency corrected on a two per cent basis would come to seventy-two per cent at saturation and about seventy-four for one hundred degrees superheat. The latter is more characteristic of steam conditions for the non-condensing reaction turbine and of the machines existing when the principle mentioned by Doctor Moss was evolved.

Another point should not be lost sight of. High efficiency, generally speaking, is easier to obtain when admission pressure and exhaust pressure are close together than when far removed. Also, more stages ordinarily use superheated steam in a non-condensing turbine, and leaving loss tends to be less than for condensing service. Thus a condensing turbine would be expected to contain more stages than a non-condensing of equal capacity and admission steam conditions, if built at equally high efficiency. The non-condensing machine tested by Dr. Stodola, however, of about twenty stages is practically equalled by American condensing machines of the same number of stages, although utilizing twice the energy per pound of steam. The latter therefore appears to be a more refined product as far as the average steam efficiency is concerned.

Turbines of medium size and highly refined design are comparatively rare in this country on account of the relation that manufacturing cost bears to economy; they appear to be more favored abroad, however. A unit of the same type as tested by Doctor Stodola is being constructed for steam at around twelve hundred pounds and nine hundred degrees Fahrenheit total temperature, containing four cylinders on one shaft, which is in advance of steam conditions so far attempted commercially over here.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for July will be announced this month.

Eliminating Trouble with Scale in Turbine Glands

When it became necessary to dismantle our turbine twice in less than three years because of scale in the glands, we determined to remedy this condition by eliminating the source of trouble. It was decided to use condensate on the glands and the system which was adopted may be of interest to other readers.

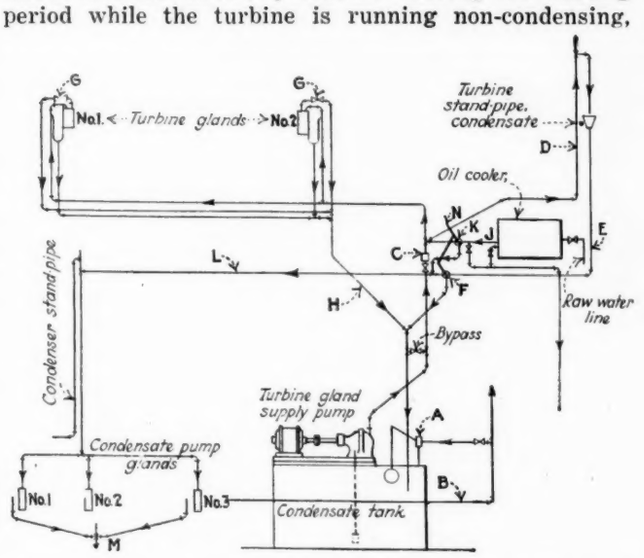
The turbine is a 500-kw. bleeder type with a 1,250-sq.ft. surface condenser. The bled steam is used to heat the feed water in an open heater and also, augmented by high pressure steam at light loads, to heat the plant during the cold weather. The circulating, air and condensate pumps are driven as a unit by a 40-hp. motor which makes it necessary, on account of the demand charge, to start each morning non-condensing and bring in the condenser after the machine is up to speed and cut in on the board. The raw water supply which was provided in the original lay-out, for the glands, contained about 200 parts per million scale forming salts and the deposit was rapid during the starting periods.

In the design of the plant, provision was made for turning condensate into the glands by giving the discharge line from the condensate pump to the heater sufficient rise for the necessary head and interconnecting it with the gland line. However, this arrangement never operated with any degree of satisfaction and could not be used in starting without installing a hot well and pump. Moreover, such a system would receive more or less raw water at the period when none would be wanted, so an independent system was finally decided upon.

One of the departments in the factory had a spare 7½ gal. per min. motor-driven pump and this was obtained and installed at a moderate initial expense. The system, as will be seen by referring to the schematic diagram, is flexible and should pump trouble develop, raw water is immediately available for the glands.

The system operates with little attention, aside from inspection and is satisfactory, as no deposit has formed around the glands after running twice the length of time previously taken to start the formation of scale. However, there was one thing that we neglected to take into consideration, which involved us when the first cold snap arrived; that was the worn condition of the glands. We discovered that with higher bleeder pressure necessary to insure steam at the other end of the plant for heating—the line being approximately 800 ft. long—the 7½-gal. pump had neither the capacity nor the discharge head to maintain the gland pressure required. Therefore it was necessary to purchase a 15 gal. per min. pump with a higher head and this unit is now in service.

In operation the level of the condensate in the tank is maintained about 14 in. below the pump by the float valve *A* connected to the line *B*, which leads from the condensate pump at the condenser to the feed water heater located at a point higher than the condenser. The pump draws the condensate from the tank and forces it through the check valve *C* to the glands and to the stand-pipe *D* which maintains a definite head on the glands. Some of the water is drawn from the glands into the condenser and the rest returns to the tank. From the stand-pipe *D* the return is through line *E* and the three-way cock *F*. During the starting period while the turbine is running non-condensing,



Arrangement of pumping unit and piping for supplying condensate to turbine glands

the pressure in the glands is relieved through the valves *G* and returned to the tank through the line *H*.

The raw water, which is used on the oil cooler, passes through the line *J*, three-way cock *K*, and the line *L* to the condenser pump glands and stand-pipe, the overflow *M* discharging into the make-up tank. The three-way cocks *F* and *K* are connected by a link and lever which allows both to be changed at once in case of

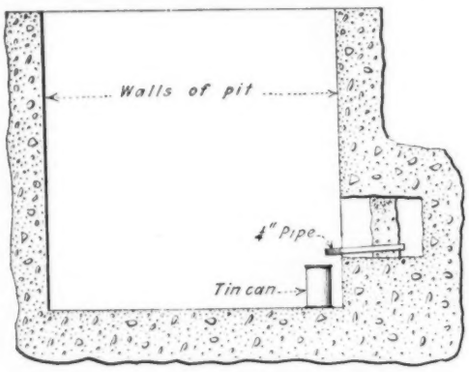
pump trouble, putting the whole system on the raw water. The pump is driven by a ½-hp. motor started from the main board.

A résumé of initial and operating costs could be given but would probably mean nothing in a locality where different conditions and prices prevail. However, the cost of operating, including depreciation, repairs, etc., has been found to be about 9 per cent of the dismantling charges. J. F. JELBART.

Meadville, Pa.

Preventing Water Seepage Into Flywheel Pit from Underground Spring

We had an experience some time ago with water seepage into a flywheel pit, and the method we used of overcoming the trouble may be of interest to other readers. A steam-driven ammonia compressor was being changed to a belt drive with electric motor, and it was therefore necessary that the pit be kept dry. A spring runs under the foundation and comes out of



Porous portion of wall was cut away and refilled to stop water seepage

the ground about twenty feet away. Water would seep into the pit and would fill up to the level in the cistern where the spring emptied.

After the old flywheel, together with the steam cylinder, connecting rod and crosshead, was removed and the pit cleaned out, the small openings between the gravel in the concrete through which the water seeped could be spotted. A portion of the wall of the pit, where the water was seeping through, was broken out about 8 in. deep. As the concrete was oil soaked, fresh concrete would not stick to it; so unslacked lime was crushed, moistened and spread over the oily surface to burn out the oil. Then we proceeded to place in the hole a small concrete barrier as shown in the illustration. The concrete was made with two parts sand and one part cement and as little water as possible. A piece of ¼-in. pipe 9 in. long with threads on one end, was embedded in the cement as shown, a can being placed under the exposed end of the pipe to catch the water as it trickled through.

The following day the water that had accumulated during the night was removed from the pit and a cap was screwed on the exposed end of the pipe. Then that portion of the wall was watched closely for an hour or so to see if it was holding. Then the remainder of the hole was filled with concrete of the same consistency as used in the barrier. The following morning the pit was dry.

The new flywheel was placed on the shaft and the foundations made for the motor and idler. While we were waiting for the concrete to harden, the pit filled again with water. On examination it was found that a similar seepage was taking place through the other wall of the pit. This was immediately taken care of in the manner just described, and since then no water has seeped into the pit.

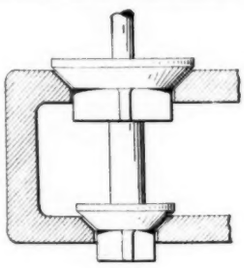
The compressor is running twenty-four hours a day under conditions that make it almost impossible to shut down without causing considerable loss, and no trouble is being experienced with water seepage into the pit. This experience has demonstrated to me that when building foundations having a wheel pit, over a spring, the water should be relieved from under the concrete when pouring, otherwise it will wash the sand and cement to the top and leave the gravel below with the voids unfilled, which will allow water to seep through the wall. H. E. MILLER.

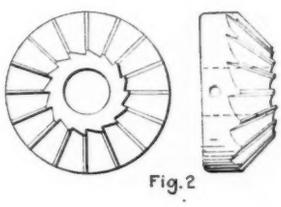
St. Louis, Mo.

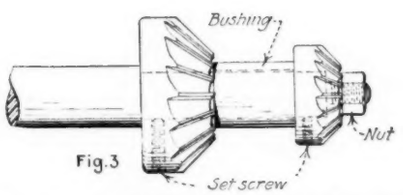
Stopping a Persistent Valve Leak

Some time ago we had considerable trouble with a reducing valve on the compressed air line. The valve was of the double-seated type, as illustrated in Fig. 1, and it seemed practically impossible to keep it tight. The leak was so small, however, that when the instruments were working we got a steady pressure line on the recording chart, but when they would shut off the air pressure would run up. Grinding the valve did not remedy the trouble as the faces of the seats were narrower than the valve disks so the more we ground the larger the shoulder it made. We tried facing up the valve, but this did not improve the operation. We then made a special tool, shown in Figs. 2 and 3, that did the trick. We had no cutters on hand small enough so we had to make them up specially for the job.

We took two pieces of stock the size of the valve seats and turned them down the same angle as on the valve, then drilled and tapped each for a set screw. We then formed the cutting edges on the disks, which were afterwards hardened and ground. The cutters were







Figs. 1, 2 and 3—Section of valve and cutters used for reseating

then mounted on a suitable mandrel as shown in Fig. 3, a bushing being used between the cutters to obtain the correct spacing. After facing up the seats with this tool so that both disks of the valve seated properly, no more trouble was had. G. M. PHINNEY.

Needham Heights, Mass.

Comments from Readers

The Use of Air Chambers on Pumps

Referring to the article by V. K. Stanley in the June 16 issue on "The Use of Air Chambers on Pumps," he makes the common error of calling the chamber on the suction line an air chamber, when it should be termed a vacuum chamber. The air chamber is always placed on the discharge of the pump to give a steady flow to the water.

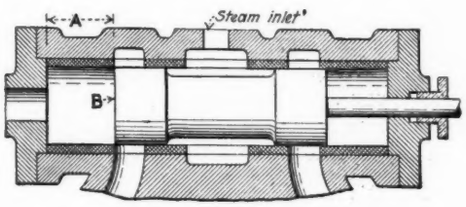
Mr. Stanley used a simple and effective method of remedying the trouble as I have overcome similar troubles in the same way. He gives the total length of the suction as 34 ft., of which 20 ft. was horizontal and 14 ft. vertical. Strictly speaking, the suction was only 14 ft. as the horizontal length is not considered, providing it is level.

F. P. KINDER.

Saxonville, Mass.

Setting the *D* Slide and Piston Valve

Having had considerable experience with various types of valves on reciprocating engines, I was much interested in the two questions in the April 28 issue, "Why cannot a *D* slide valve be operated by fixed accentric to cutoff before $\frac{5}{8}$ stroke?" and "How can a *D* slide valve be set to obtain cutoff at $\frac{3}{4}$ stroke?"



Cross-section of piston valve chamber

In our plant we do not set a *D* slide valve to obtain the desired cutoff. We set it for the direction of rotation and lead, and the lap takes care of the cutoff. We do not always remove the steam chest cover for access to the valve, for many times it is a piston valve with inside admission and no hand holes provided, for inspection.

We have engines of all kinds, including twin-tandem compounds reversing with 42-in. piston valve on the low-pressure cylinders and link motion with 12½ in. valve travel. Also several engines of the Corliss and automatic cutoff valve types, with the unaflow thrown in for good measure. So sometimes a "Feller needs a friend" and that friend is the indicator to be used with a clear understanding of fundamentals and the conditions of the case in hand.

A few years ago owing to the unsatisfactory operation of the old governor and valves on one 46x60 in. and one 40x60 in. single-cylinder non-condensing piston valve engines, it was decided to install shaft governors, new valves and new valve cages in the valve housings.

When the new parts were all on the ground it was decided to shut the plant down on Friday morning and raise the crank shafts (one of which was 24 in. in diameter), to babbitt the main bearings and put on the new governors, and then to start up again on Sunday at 5 p.m. with both engines fitted with new governors and valves complete.

We had to strip the old governors, eccentrics and governor pulleys from the shaft, also the old piston valve and bushings from the housings, then machine new valve bushings to fit and pull the bushings into place.

Before assembling the new parts we took the necessary measurements for setting the new valve, for after the valve is in place the only edge available is the exhaust edge *B* at the head end, as shown in the illustration, there being no hand holes for observation on these valve housings. The valves were 24 in. in diameter with inside admission, and 10 in. maximum travel.

After assembling the governor wheel, eccentric and yoke on the engine shaft, we calculated the length of the new eccentric rod and got it welded at the forge shop, then connected it to the valve and checked for length of eccentric rod and valve stem and also for correct position of governor wheel on the shaft, finally clamping all parts in place.

All setting and adjustments were made without moving the engine shaft or rolling the governor wheel around the shaft, until steam was turned on and the flywheel pryed off center to start operation of the mill. All of which was accomplished on time and the engines operated satisfactorily.

Youngstown, Ohio. D. P. POLTON.

Do Water-Cooled Furnace Walls Increase Boiler Efficiency?

This is in reply to Mr. Fisher's letter which appeared on page 881 of the June 2 issue.

The test, to which I referred in my letter in the April 7 issue, is described in a paper entitled "Tests of a Type W Stirling Boiler at the Connors Creek Power House of the Detroit Edison Company," presented by P. W. Thompson at a meeting of the A.S.M.E., December, 1922. The heat absorption in the furnace with the original baffle is almost identical at the same boiler ratings, with that using the "B" baffle, which reduced the actual heating surface by one-half.

It appears, however, that I was unwise in drawing a general conclusion from the results of this test. As Mr. Fisher points out, with the original baffle the available heating surface may not have been arranged to the best advantage for heat absorption. Since writing the letter that appeared in the April 7 issue, I have been studying the work of W. J. Wohlenberg and D. G. Morrow, which was described in a paper presented at the spring meeting of the A.S.M.E. in May, 1925. I can do no less than withdraw my opinion, as based on incomplete evidence and study, and refer Mr. Fisher

to the paper just mentioned. It would appear that "the amount and disposition of the refractory lining" and therefore of the cold surface does indeed have an effect on furnace performance. JULIAN HARVEY.

Detroit, Mich.

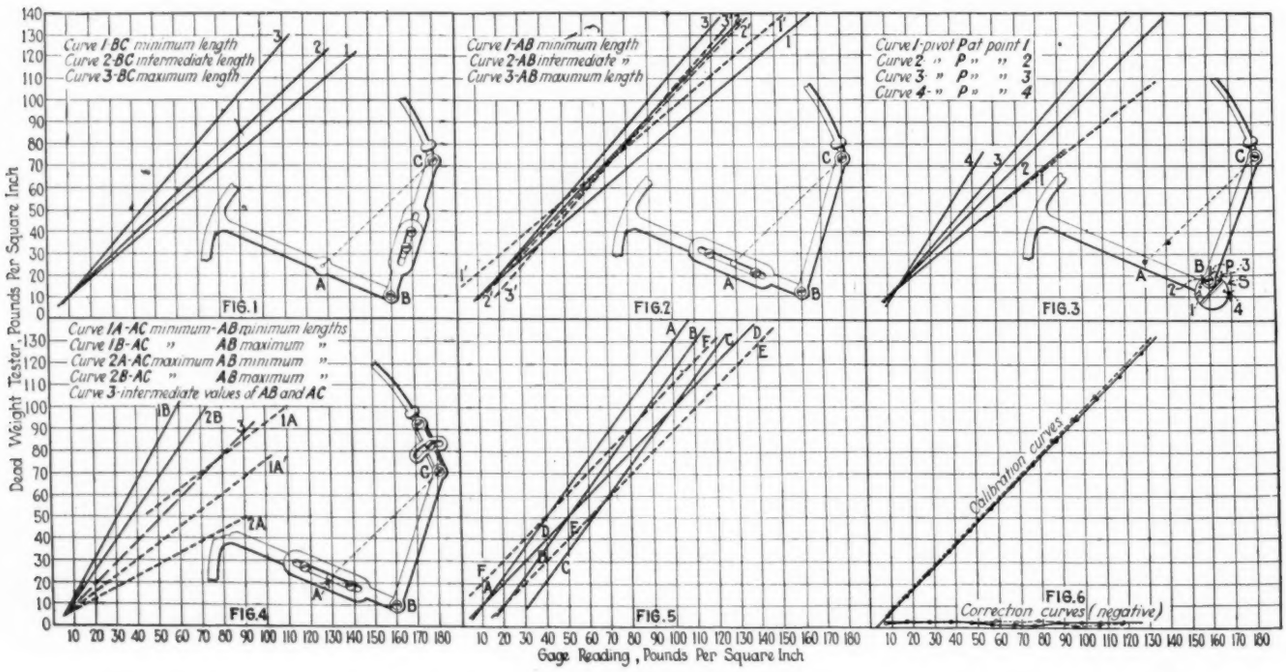
Correction of Bourdon Pressure Gages

Several months ago an article appeared in *Power* in which various methods of adjusting a bourdon pressure gage, under certain conditions, were summarized. To these methods might be added the one mentioned in the article by Mr. Beck in the May 12 issue. In this article the author outlined the principle underlying the adjustments, such as, varying the angle *ABC*, Fig. 1, and by changing the length of one or more of the sides *AB*, *AC* or *CB*, where *A* represents the center of the segment arc, *B* the point where the connecting link pivots on the segment and *C* the point at which the connecting link pivots on the spring and piece.

Several years ago I had occasion to make the curves, shown in Figs. 1 to 5, illustrating the effects of various adjustments upon the reading of a gage. These curves show graphically the effect of changing the angle *ABC* by various methods as shown on Figs. 1, 2, 3 and 4. The curves are numbered so that 1 represents the minimum length of the side being considered, 2 a longer length and so on, to the maximum length of the side, the tester values being plotted on the vertical axis and gage readings on the horizontal axis. Thus it is seen that, decreasing the angle *ABC* causes the pointer to move slower and give a lower reading for the same spring deflection. This angle may be decreased by lengthening *AB* or *BC* or by shortening *AC*. Fig. 1 illustrates the adjustment by means of *BC*, Figs. 2 and 3 by means of *AB* and Fig. 4 by means of *AC*, *AB* or a combination of the two. Fig. 3 illustrates a cam motion at the end of the sector arm. The connecting link instead of being pivoted to the sector arm is fastened to the pin *P* some distance from the center of the screw head *S*. Rotating the adjusting screw, therefore, changes the location of the pivot point with reference to the points *A* and *C*, changing the effective length of *AB* and the corresponding angle *ABC*. The effect of changing *AC* is shown in Fig. 4 by curves 1*A* and 2*A* or by 1*B* and 2*B*, the difference between the *A* and *B* curves being caused by a change of *AB*, illustrating the effect of the second adjustment.

The pointer, after each adjustment, was set arbitrarily at a low value of 10 or 15 lb. to show the effect of the adjustment as clearly as possible. The pointer could have been set at any desired value, say 75 lb., the effect of this being shown by the dotted lines in Fig. 2. This is shown again by Fig. 4. Curves 1*A* and 1*A'*, where after adjustment, a pressure of 65 lb. was necessary to bring the sector in contact with the pinion, the pointer being set at this point. Changing the adjustment of the gage will change the slope of the line, while changing the needle only, will leave the slope unchanged but move the curve to the right or left parallel to the original. If after testing, a curve similar to *A* in Fig. 5 is obtained it may be shifted to *B* or *C* by simply changing the pointer. As the gage adjustment is corrected the three lines will approach one another until at the point of perfect adjustment they would coincide (curve *D*). Curves *E* and *F* illustrate correct adjustment but wrong pointer setting. Changing the location of the segment center as mentioned by Mr. Beck would in effect change the distance *AC*. As the angle *ABC* decreases with the length of the side *AC*, the effect of shifting the center upward would be similiar to the change from 2*B* to 1*B* of Fig. 4. No data on double spring gages are available; curves can, however, easily be made by means of a dead weight tester and an old gage by altering the adjustments and plotting the results on coordinate paper.

The curves illustrated in Figs. 1 to 6 were made in connection with a gage record and inspection system, developed to take care of about forty gages used in, or in connection with, the test department of a manufacturing company and were drawn as straight lines to illustrate the principle of adjustment, slight curves which will appear at the extremes being neglected. All


Curve 1-BC minimum length
Curve 2-BC intermediate length
Curve 3-BC maximum length
FIG. 1
Curve 1-AB minimum length
Curve 2-AB intermediate "
Curve 3-AB maximum length
FIG. 2
Curve 1-pivot P at point 1
Curve 2 " P " " 2
Curve 3 " P " " 3
Curve 4 " P " " 4
FIG. 3
Curve 1A-AC minimum-AB minimum lengths
Curve 1B-AC " AB maximum "
Curve 2A-AC maximum AB minimum "
Curve 2B-AC " AB maximum "
Curve 3-intermediate values of AB and AC
FIG. 4
FIG. 5
Calibration curves
Correction curves (negative)
FIG. 6
Dead Weight Tester, Pounds Per Square Inch
Gage Reading, Pounds Per Square Inch

Figs. 1 to 6—Curves illustrating the effects of various adjustments upon the reading of a gage

gages were numbered, the numbers being cut from black paper, made about three-quarters of an inch high and pasted on the inside of the glass. A card, Fig. 7, was filled in for each gage as purchased and filed in a Rand visible card index. In addition to the calibration of gages used for a particular test, the gages were tested in numerical order at the rate of three a day, the test man filling in the data sheet Fig. 8, and plotting the results on coordinate paper. Any adjustments

Gage No. _____ Range _____ Service _____
Mfg. _____ Serial No. _____
Req. No. _____ P.A.O. No. _____ Mfg.O.No. _____
Received _____ Discarded _____ Cost _____

Service				Tests		
Location	From	To	Months	Date	No.	Tester
Total Service				Cost Per Month of Service		

No. _____ Range _____ Service _____

Fig. 7—Reproduction of record card for each gage

necessary were made, records of the first and last test being plotted and filed after making the necessary record on the form Fig. 7. Spare gages in the store room were marked in the index by means of colored markers, red for steam, green for water and yellow for air. This made it easy to locate a gage for any particular condition or service, and in case a question arose as to the accuracy of a certain gage, the files contained a calibration curve for each gage for practically every two weeks.

As suggested by Mr. Nichols, ordinary gages, which cannot be accurately adjusted over the entire range, should have the needle set for the average condition. Standard test gages should not be adjusted or changed, but should be calibrated and a correction curve made for use with them if necessary. Gages of this kind, if not correct, are more convenient for use if the pointer is

BOURDON GAGE TEST

Test No. _____ Gage No. _____
Date _____ Mfg. _____
Range _____ Serial No. _____

Tester	Gage			
	Up	Down	Mean	Correction

Remarks _____

Tested by _____

Fig. 8—Gage data sheet

set correctly at a low value so that the correction will be either positive or negative over the entire range of the scale as shown in Fig. 6.

In using the dead weight tester, the weights should be gradually increased and kept spinning so that the pointer is continuously going up with the lost motion always on the same side. After the maximum value has been reached the weights should be gradually decreased in the same manner, so that the lost motion is always on the opposite side. The latter operation requires some practice and an oil-tight machine. The readings for decreasing values will usually exceed those of the increasing values by a slight amount, depending upon the condition of the gage and whether or not the pointer is equipped with a spring. The mean value of the two should always be used. Fig. 6 shows a typical test gage calibration and correction sheet.

The periodic testing of gages, their proper location and support, is a matter often overlooked. Recently, an excessive steam line pressure drop of 24 lb., when investigated, was found to consist of 4 lb. loss through the superheater and 3 lb. loss in the main, the remaining 17 lb. being made up of 5 lb. gage error, a water leg of 17 ft. on one gage and a negative water leg of 11 ft. on the other gage, the latter being caused by locating the pipe so it could not drain properly.

Gages which have been damaged by overpressure or live steam, so that they no longer show equal deflection for equal pressure increments, should be discarded or sent to the factory for repair. Testing one gage a week will in the average plant keep all gages in first class condition and, on investment of a few dollars for a suitable tester, will more than repay the engineer who takes a justifiable pride in a well-regulated plant and in the safety resulting from reliable instruments.

Clarkdale, Ariz. RICHARD H. MORRIS.

Explosions in Air Receivers

In the June 30 issue is an abstract of a paper, "The Prevention of Explosions in Air Receivers," by William F. Parish and William B. Smith Whaley, read before the Metropolitan Section, Petroleum Division, American Society of Mechanical Engineers. In the paper are the following statements:

> Whenever a space is left in the air system for these vapors to collect, and especially where cooling takes place, these vapors and gases will associate together in strata, the heaviest will settle and the lightest will rise and pass off in circulation whenever possible.
>
> A highly explosive and critical area is therefore present in every unscavenged static receiver or tank when air and combined combustible vapors and gases are present, as is the case in air-compressor receivers. This critical area exists at some point between the tank bottom, where the heavier parts of the atomized oil will settle out, and the top strata, which contains the most volatile gases.
>
> Should the area of critical mixture lie in the center of the tank surrounded by free air, it will be safely cushioned. Should the tank contain a sufficient amount of combustible vapors lying in strata, ignition of the unstable and critical mixture can take place, and owing to the over-richness of the adjoining lower strata the action . . .
>
> If conditions are such that detonation of the critical mixture will fire the entire series of strata, . . .
>
> . . . This effectually sweeps all vapors and gases from the receiver and keeps it full of pure fresh air with only a minute amount of oil and vapors that, however, do not have a chance to collect and stratify.

Now, if the different gases and vapors stratify as stated in the foregoing, what becomes of the kinetic theory of gases? We are all familiar with liquids that stratify because of differences in their specific gravities, but if this were the behavior of gases, wouldn't we be in difficulty with the atmosphere, which is composed of a mixture containing enough carbon-dioxide to form a layer on the earth's surface at sea-level of about ten feet? An explanation by the authors of the paper quoted would be interesting, and might clear up this (to me) anomalous behavior of gases.

Los Angeles, Calif. C. O. SANDSTROM.

Shall He Take a Chance?

In discussing the Foreword entitled, "Shall He Take a Chance," which appeared in the April 14 issue, G. G. Brown in the May 26 issue asks the question, "Is not the era of the self-trained man past?" Is not the man referred to held back largely because of his lack of a college education? In replying to these questions I would say emphatically no.

In this country there are several universities that provide extension or correspondence courses which carry credits on units of subjects taken up. So there is more than one way of securing a college education or its equivalent.

Mr. Brown gives his age as twenty-four and his occupation as draftsman. At his age I had a trade as an apprentice machinist, also held a second assistant engineer's ocean-going license. At thirty-four, I held a position as chief engineer and at forty-five I had had eight years of power-plant experience with the position of chief engineer in a 12,800-kw. plant and am now in a 75,000-kw. plant. I have no difficulty in finding my ability recognized. Concentration, personality and loyalty to your employer are the essential qualifications. The average man dreams of success and hopes he will be lucky.

When one is working for himself planning and studying means a larger income. When working for someone else it results in increase of wages or better position. I have subordinates who are college graduates but they see that theory without practice is not of much avail. Extraordinary success often comes from ordinary abilities combined with extraordinary energy.

San Francisco, Cal. C. ALEXANDER.

Mr. Brown raises a question which is more momentous than the original question "Shall He Take a Chance?" which has been fully answered by the editor in his "Foreword." It is not what one knows that counts. It is what he is able to put across that determines his failure or success. We all know some bright engineers occupying insignificant positions. Some of us know some successful engineers who have either forgotten, or never knew the fundamentals of technical engineering. Only recently I came across a consulting engineer of international reputation who rejected the report of an exhaustive boiler test because "it was wrong on the face of it; the CO_2 plus O_2 adds up to slightly over 15 per cent and it should add up to about 20 per cent." As it happened to be an oil-fired boiler, the joke was on the consulting engineer.

The issue raised by Mr. Brown is that of judging a man not on his merits, but by attributes over which he had little or no control. Mr. Brown is young and fate has apparently been kind to him for he seems to think that the discrimination against self-educated men in favor of college-trained men he has met with, is the only obstacle in the path of an ambitious man, and that it is unsurmountable. It is true that the college man is discriminated against in favor of the self-educated man in some quarters and vice-versa in others. While the college-trained man has a marked preference for a similarly trained man, the self-educated man, it seems to me, has seldom anything but contempt for the college-trained man and seldom, if ever, misses an opportunity of showing it. And as the percentage of self-educated men in executive engineering positions by far exceeds that in any other profession, many a technical graduate wishes he had spent four years as fireman or oiler, instead of at college. If proof of the correctness of the foregoing statements were necessary, I could mention two manufacturers of electrical machinery that wouldn't have a college man around. I could mention a large public utility corporation where a college man hasn't got a chance. The reason for this is the narrow-mindedness of the self-educated men at the head of those organizations.

The same narrow-mindedness on the part of men in executive positions is responsible for the discrimination in favor of graduates of one and only one school, the favoring of members of a certain fraternal order in one organization, the discrimination against members of the same fraternal order in other organizations. The discrimination against men born of certain nationalities and in certain faiths is a matter of common experience in the engineering profession, more so than in any other profession or walk of life.

However, let our young and aspiring men like Mr. Brown not despair! But let them bear in mind that the time-tested, time-honored adage, "You cannot keep a good man down; if he has got the goods, it is bound to come through," still holds. Let no trifles like unjust discrimination dishearten them. Let them brush aside those obstacles and proceed steadfastly toward their goal, cost what it may. And if the organization they are in hinders them, let them not hesitate long in cutting loose. Eventually they will find the organization that will appreciate and welcome them.

The discussion brings to mind a beautiful poem by Edgar A. Guest, which follows in full:

I care not what his creed may be,
Nor what his cast or clan,
He still shall be a friend to me,
If he but plays the man.

No barrier or creed shall fling
Its prejudice before
The honest man who comes to bring
His friendship to my door.

If he be gentle, brave and true,
And stand with head erect,
This much he is entitled to,
My friendship and respect.

And if he be ill-mannered here,
Selfish and speak the lie,
I shall not hold his conscience clear
Because he prays as I.

I shall not bother with the shame
Of any sinful deed,
Or seek to gloss a tarnished name
With luster of a creed.

I shall not ask his form of prayer,
Nor what his church may be,
The good man, kind and just and fair,
Shall find a friend in me.

New York City. E. OGUR.

At 60 deg. a cubic foot of saturated air contains 0.00083 lb. of moisture. This increases to 0.00285 lb. at 100 deg. and 0.030 lb. at 200 deg. These are exactly the same as the weight of a cubic foot of saturated steam at the given temperatures.

Questions and Answers

Conducted by

Franklin Van Winkle

Cutting Glass Tubing

How can thin glass tubing used in an Orsat be cut to the desired length? W. L. D.

Thin glass tubing can be broken off at desired lengths by first making a scratch around the tube with a sharp three-cornered file; then grasping the tubing firmly in both hands with the thumb nails coming together at the scratch, the tube is to be partly pulled apart and partly bent, when it will break squarely at the scratch. With a little practice tubes of uniform thickness can be broken in this manner to the desired length with few failures from breakages.

Safe Working Pressure for H. R. T. Boiler

What would be the allowable working pressure with factor of safety of 5 for a horizontal return-tubular boiler 80 in. in diameter having shell plates $\frac{3}{8}$ in. thick of 60,000 lb. tensile strength and efficiency of longitudinal joint 70 per cent? M. D.

The allowable working pressure for any boiler is the least working pressure that would be allowable for any part of the boiler. If the allowable working pressure depends on the strength of the longitudinal seam where the diameter of the shell is 80 in., thickness of plate $\frac{3}{8}$ in., tensile strength of plate 60,000 lb. per sq.in., efficiency of joint 70 per cent and factor of safety 5, then the allowable working pressure for the boiler would be $(\frac{3}{8} \times 60{,}000 \times 0.70) \div (\frac{1}{2}$ of $80 \times 5) =$ 78.75 lb. per sq.in.

Inches of Pressure

What is meant by pressure in inches of water or inches of mercury? C. T. J.

Low pressures of gases, vapors and liquids are conveniently measured by or referred to the hydrostatic pressure exerted by the head or height of liquids of known density. Measurements of such pressures usually are made by observing the difference in height of liquid columns required to balance the difference of pressure exerted on the surface of the liquid in the branches of a U tube; or by direct measurement of the height of a single column, as in a barometer, where atmospheric pressure, acting on the surface of mercury balances a column of the liquid in a vertical tube, the lower end of which is in communication with the liquid in a cup or "well" while the upper end of the tube has a sealed space which is a vacuum. The pressure per square inch for each inch in height of a column of any liquid which like water or mercury may be regarded as incompressible, will be the same as the weight of one cubic inch of the liquid. The pressure of 1 in. of water at the temperature of 62 deg. F. = 0.03609 lb., or 0.5774 oz. per sq.in.; and the pressure of 1 in. of mercury at the temperature of 62 deg. F. = 0.491 lb. or 7.86 oz. per sq.in.

Power for Pumping Lost in Pipe Friction

When a pump works against a given head, what effect has the size of the discharge pipe on the power required? W. H. A.

For the same rate of pumping the power required will be practically as the discharge pressure at the pump. For a constant rate of discharge and the same head pressure at the pump it is immaterial what may be the size of discharge pipe beyond the pump or whether the discharge pressure results from throttling a valve on the pump discharge outlet without any discharge pipe. However, if the water must be delivered through a discharge pipe to a given height or against a given pressure at the point of final discharge, the smaller the discharge line the greater the pipe friction to be overcome and the greater must be the discharge pressure at the pump since it must be equal to the loss of head from pipe friction plus the final discharge pressure.

Inside and Outside Fusible Plugs

What is the difference between an inside and an outside fusible plug? L. E.

When the form of the boiler requires insertion of the plug from the fire side of the sheet, the plug used is designated an ouside plug. When the plug is to be inserted from the inner or water side of the sheet, it is designated an inside fusible plug. When the plug is in the simple form of a pipe-thread bushing filled with the fusible metal, the diameter of the filling usually is larger at one end than at the other and the larger diameter is intended to be on the water side. Hence, a fusible plug of this form intended for an outside plug would have the larger diameter of the fusible filling in the screwed end of the plug, and an inside plug would have the larger diameter of the filling on the head end of the plug. A combination plug, for use as either an inside or outside plug, is made in the form of a bushing with the fusible metal enlarged to the same diameter at both ends of the plug.

Slower Speed for Lower Initial Pressure

For the same load resistance on an engine and without making any change in the governor mechanism, why must reduction of initial pressure be accompanied by a decrease of the speed? H. H. C.

The same resistance to the piston requires the same m.e.p. With an automatic cutoff governor, a lower initial pressure requires a later point to cutoff which can be obtained only by a slower speed of the engine and governor. When lower pressure of steam is supplied to an engine with a throttling governor, the same m.e.p. is not obtainable with the same piston speed, as steam of lower pressure is supplied at lower velocity and, to supply the larger volume required per stroke for maintaining the necessary m.e.p., there must be

wider opening of the governor valve which is obtained only by a slower speed of the engine. Hence with either type of governor, for each particular initial pressure of steam, or conversely for each particular m.e.p., there will be a corresponding speed of the engine, unless the governor is so designed that it will be loaded and unloaded within itself or is compounded with an auxiliary governor which will load and unload the principal governor when the normal position of the auxiliary governor is not satisfied. Such auxiliary governors have been used to good advantage on engines of textile spinning mills.

Reasons for Excessive Back Pressure

If indicator diagrams taken from a non-condensing engine show excessive back pressure, how can the cause be located? *W. L. G.*

Undue back pressure shown on an indicator diagram may be due to leakage of steam valves during an exhaust stroke, leakage of engine piston or an obstruction to the free discharge of the exhaust. By taking a diagram with the indicator connected to the exhaust pipe near the engine, the same or nearly the same indication of back pressure would signify that the exhaust pipe was insufficient in size for its length and number of elbows or that it was improperly dripped or otherwise obstructed, as by a partly closed back-pressure valve or from receiving the exhaust of pumps, traps or other engines, or backing up of live steam used to supplement the exhaust when used for heating. If, however, the diagram from the exhaust pipe showed a decided drop in pressure below the back pressure shown by diagrams taken from the cylinder of the engine, it would signify that the engine's exhaust was choked by late or insufficient opening of the exhaust valves, by contracted exhaust-passages, or excessive leakage of the piston or of the steam admission valves.

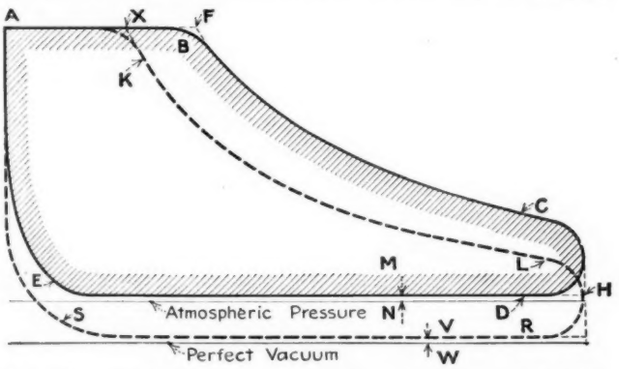
Improper opening of the exhaust valves would be shown on the diagrams as slow reduction of back pressure in the beginning of the exhaust stroke. Leakage of steam valves can be tested by blocking the engine first on one center and then on the other, or enough forward of dead center to cover the lead, and when the throttle valve is open observing whether steam escapes from the indicator cock or cylinder pet-cock on whichever side of the piston the valve should be closed. Piston leakage usually is determined by blocking the engine at any desired point of the stroke and with the cylinder head removed, observing the leakage when steam is admitted to the crank end of the cylinder.

Advantages of Operating Condensing

When operating with 125 lb. boiler pressure what would be the advantage of operating a simple engine condensing with 25 in. vacuum and feed water at the temperature of 160 deg. F. in place of operating non-condensing with the feed water at the temperature of 210 deg. F., in a plant where, when operating non-condensing, one-sixth of the steam generated is supplied to the engine. *L. P. W.*

For a given load the reduction of steam used by the engine operating condensing in place of non-condensing would be practically the same as though the m.e.p. required for the load were reduced as much as the back pressure is reduced.

Referring to the sketch, if the shaded area *ABCDE* represents the indicator diagram obtained when operating non-condensing, with theoretical cutoff at *F* and back pressure *MN* of 2 lb. above the atmosphere, or 15 + 2 = 17 lb. per sq.in. absolute; and if *AKLHRS* represents the diagram obtained for the same load with theoretical cutoff at *X* and back pressure of 25 in. vacuum, making $VW = (30 - 25) \times 0.49 = 2.45$ lb. per sq.in. absolute, then when operating condensing as compared with non-condensing there would be relief of 17 — 2.45 = 14.55 lb. back pressure and the steam consumption would be approximately the same as though the engine continued to operate non-condensing, but was relieved of enough load to obtain a diagram *AKLHDE*, with theoretical cutoff at *X*. Assuming that the steam consumption per pound m.e.p. when operating non-condensing with cutoff at *X* is the same as for cut-



Superimposed indicator diagrams operating condensing and non-condensing

off at *F*, and the full load requires 50 lb. m.e.p., then when operating condensing the steam consumption by the engine would be $(50 - 14.55) \times 100 \div 50 =$ about 70 per cent as much as when operating non-condensing.

However, for comparison between economy running condensing and non-condensing there should be an allowance of about 7½ per cent for the operation of circulating and air pump, making the steam required approximately $70 \times 1.075 = 75.25$ per cent as much as for non-condensing.

Each pound of initial steam at 125 lb. gage or 140 lb. per sq.in. absolute, contains 1,192.2 B.t.u. When operating condensing with the feed-water temperature 110 deg. F., the heat of the liquid would be 77.94 B.t.u. and each pound would receive 1,192.2 — 77.94 = 1,114.2 B.t.u. When operating non-condensing with the feed-water temperature 210 deg. F., the heat of the liquid is 178 and each pound of feed water must receive 1,192.2 — 178 = 1,014.2 B.t.u. But if only 75.25 per cent as much steam is required, when operating condensing the saving would be $100 - (75.25 \times 1{,}114.2 \div 1{,}014.2)$ = about 18 per cent of steam required by the engine, and since this applies to only ⅙ of the steam generated, the plant saving would be ⅙ of 18 = 3 per cent.

Supplementing Exhaust with Live Steam

How should a pressure-reducing valve be adjusted when live steam is used to supplement exhaust for heating? *R. L.*

The pressure-reducing valve should be adjusted to discharge a pound or two lower pressure of steam than the pressure relieved by the back-pressure relief valve. Otherwise there is likely to be waste of live steam.

A new slant on things observed in and out of the power plant

What Happens and Why?

Why High CO_2 Lowers Flue Temperature

HIGH CO_2 signifies low excess air, which in turn makes for high *furnace* temperature. It is not difficult to see that the smaller the quantity of gas in which the heat is released the greater must be the resulting temperature. But high CO_2 usually goes with low *flue* temperatures. This is much harder to understand. If the gas is hotter when it enters the tubes, why is it not also hotter when it leaves? Yet with few exceptions, tests show the reverse to be the case.

It will help in understanding this if we first take up a hypothetical mathematical proposition that is rather interesting but would seem, at first, to have no practical application.

Two travellers *A* and *B* (Fig. 1) start for the same destination. *A* starts from the more distant point. It is agreed that *A* shall cover each day one half of the remaining distance to the destination and *B* one third the remaining distance. Now under this ruling neither will ever reach the destination, since there will always be some small distance left at the end of each day. A fraction of something is never nothing.

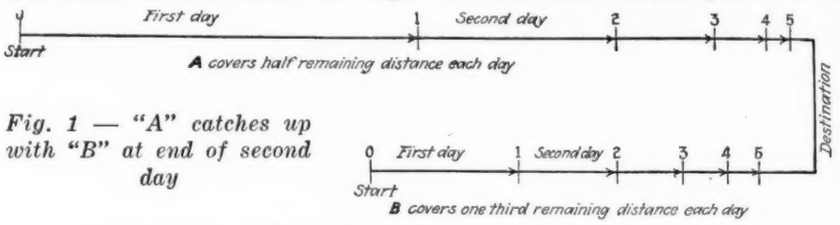


Fig. 1 — "A" catches up with "B" at end of second day

The question is: Will *A* ever pass *B*? The answer is that he will. In Fig. 1 *A* overtakes B at the end of the second day. Thereafter he is always nearer his destination, although gaining on *B* more and more slowly each day.

However close *B* is to the destination at the start, *A* must eventually pass him. In Fig. 1 it takes only a little while for *A* to pass *B*. Fig. 2 shows another case where it takes longer. Here *A* covers one-quarter the remain-

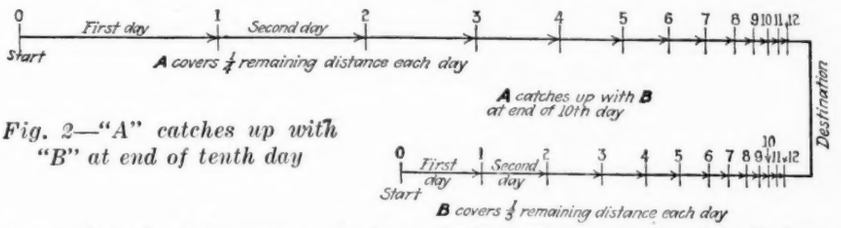


Fig. 2—"A" catches up with "B" at end of tenth day

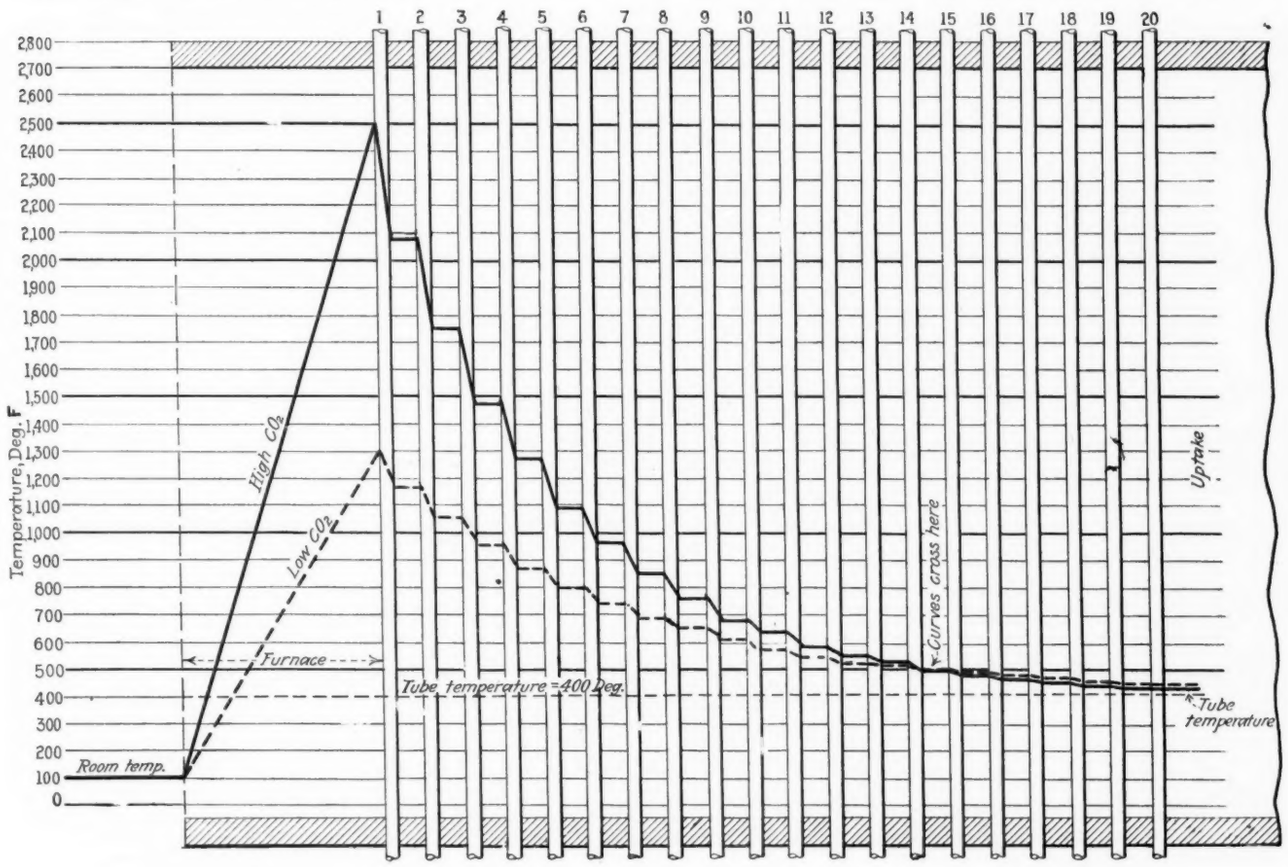


Fig. 3—For the particular conditions assumed the higher CO_2 gives lower gas temperatures beyond the fourteenth tube

ing distance each day and *B* one-fifth. Note that the difference between these fractions is small. *A* does not overtake *B* until the end of the tenth day. By that time they are so close to the destination that *A* can never get very far ahead.

This covering a certain fraction of the remaining distance each day, without ever reaching the destination, is like the fall of temperature of hot gases passing over a series of (boiler) tubes containing water at a constant temperature. Roughly speaking, the gas temperature falls a definite fraction of the distance (temperature difference) to the tube temperature for each tube it passes. This assumes that the heat transferred is in direct proportion to the difference of temperature between the gas and the tube. Thus the fall is greatest in passing the first tube and grows less for each succeeding tube. No matter how many tubes there are, the gas temperature can never quite reach the tube temperature.

Now assume that the boiler shown digrammatically in Fig. 3, is operating with high CO_2 and a furnace temperature of 2,500 deg. With this amount of gas flowing it will be assumed that sufficient heat is transferred at each tube to cause the gas temperature to fall one-fifth or 20 per cent of the remaining temperature difference between gas and tube (assumed as 400 deg.) for each tube it passes. Thus the total difference at the first tube is 2,500 — 400 = 2,100 deg. and the fall will be 2,100 × 0.20 = 420 deg., so that the gas will pass to the second tube at 2,500 — 420 = 2,080 deg. There the remaining temperature difference will be 2,080 — 400 = 1,680 and the drop 1,680 × 0.20 = 336 deg., reducing the gas temperature to 2,080 — 336 = 1,744 deg. and so on for the other tubes.

Now assume that, without changing the rate of coal consumption, a lot of excess air is admitted, lowering the CO_2 and bringing the furnace temperature down to 1,300 deg. This is much too low for practice, but will illustrate the point.

Assume that there is twice as much gas per hour as in the first case. If each tube absorbed the same *amount* of heat as before per hour per degree temperature difference, the fall in *temperature* would be only 10 per cent of the temperature difference instead of 20 per cent, because the same total loss of heat produces only half as much temperature drop if the weight is doubled.

However, greater gas flow means greater velocity, with a resulting scrubbing action on the tubes which increases the total heat transferred for a given temperature difference. Doubling the weight of gas doubles the velocity. While it increases the heat flow for a given temperature difference, it does not ordinarily double it. Say it increases the heat flow by 50 per cent. That will increase the temperature drop per tube from 10 per cent of the temperature difference to 15 per cent. The last three columns of the table are figured out on this basis.

The analogy with the two travellers is perfect. "Traveller" *B* (low CO_2) is nearer the destination (tube temperature) at the start, but covers a smaller fraction of the remaining "distance" (temperature difference) each "day" (that is, each tube). Hence *A* must eventually overtake *B*. As shown in the table and in Fig. 3, this occurs at the 14th tube with the given particular assumptions. Beyond that point the lower CO_2 gives a slightly higher temperature. With different assumptions the curves would cross at some other tube. In ordinary boilers and with commonly found values of CO_2 the curves cross before the uptake is reached, so that lowered CO_2 gives increased flue temperature. Thus low CO_2 generally shows a double loss—more hot gas thrown up the stack, and at a higher temperature.

COMPUTATIONS FOR GAS TEMPERATURE AT EACH TUBE

	High CO_2			Low CO_2		
Tube	Temp. Gas Reaching Tube	Gas Temp. Minus 400	Temp. Drop	Temp. Gas Reaching Tube	Gas Temp. Minus 400	Temp. Drop
1	2,500	2,100	420	1,300	900	135
2	2,080	1,680	336	1,165	765	115
3	1,744	1,344	269	1,050	650	98
4	1,475	1,075	215	952	552	83
5	1,260	860	172	869	469	70
6	1,088	688	138	799	399	60
7	950	550	110	739	339	51
8	840	440	88	688	288	43
9	752	352	70	645	245	37
10	682	282	56	608	208	31
11	626	226	45	577	177	27
12	581	181	36	550	150	23
13	545	145	29	527	127	19
14	516	116	23	508	108	16
15	493	93	18	492	92	14
16	475	75	15	478	78	12
17	460	60	12	466	66	10
18	448	48	10	456	56	8
19	438	38	8	448	48	7
20	430	30	6	441	41	6

The "Norman" Disaster Investigation

Water in the holds of the towboat *Norman* probably was the chief factor contributing to the loss of that vessel May 8 in the Mississippi River, sixteen miles below Memphis. The capsizing of this boat, which was being used to convey a party in attendance at a convention of the Mid-South Engineers, to inspect revetment work, resulted in the loss of eighteen passengers and five members of the crew.

The board of inquiry which just has completed its investigation of the disaster, finds that probably as much as twenty-two tons of water had found its way into the hold. In addition the boat just had filled its fuel-oil tanks. Because of the character of the construction of the center bulkhead, which the board criticizes, these large quantities of liquids were free to move until the accumulated weight of oil, because of its viscosity, kept both oil and water on the same side. Despite this the board finds that the accident would have been avoided had it not been for other highly contributory causes.

The Board was composed of Maj. H. H. Stickney, Jr., Corps of Engineers, District Engineer, Dredging District; Capt. Edw. N. Chisolm, Jr., Secretary Mississippi River Commission; A. Miller Todd, Assistant Engineer, 3rd District; W. S. Mitchell, Assistant Engineers, Western Division; and F. H. Hilliard, Assistant Engineer, Dredging District.

Prior to and on the day of the trip inspections of the boat were made by officials of the District Supply and Repair Depot and by the licensed officers of the vessel, in preparation for the large number of guests expected on board. These inspections and preparations seem to have consisted mainly in looking after appliances for the safety and comfort of the passengers, but for the vessel seem rather to have been cursory rounds of a boat thought to be in all respects in good order. The siphons are said to have been operated to exhaustion point of water in the holds, but the latter were not examined further, to determine ingress of water other than from condensation. The hatches throughout the waist of the boat, however, were battened and bolted down, anticipating unusual shipping of water over the low sides and head of the *Norman* when so deeply laden and running free. Yet when from repeated careenings it began to be suspected by a number on board, including officials of the district, that the holds might be deep in water, removal of the hatches for examination was demurred to and deprecated by the officer of the boat on the lower deck because of the danger of taking water from the deck which was continually awash, but stopping or landing the boat for examination was not suggested.

The arrangement for crew for the occasion proved inadequate. The master and pilot of the boat was unable to act as master by engrossing duty as pilot, and only learned imperfectly, and from time to time, the conditions on the lower deck through reports from others, some of whom did not recognize fully the great danger indicated by the extreme careening and wallowing of the boat on the upstream trip. The master and pilot also seems not to have appreciated, from such reports, the gravity of the situation, and probably, at the last, with too great deference to a general, and veiled, instruction "to land the boat," from his higher district officials, followed literally the instruction and indication of landing place across the deepest and swiftest water in the vicinity, in which the boat sank. It is inconceivable that one who had had so many years of experience on passenger vessels, would have followed that dangerous course rather than attempt beaching the boat on the shallow Arkansas side had he been so clearly informed of conditions as to have been fully alive to the danger that threatened.

The chief engineer, head fireman and head deckhand seemed to have been active, alert and efficient in routine duty, but were young both in years and in experience in authority.

The many indirect influences above recited, are considered contributory to the disaster.

From the foregoing statement of causes, it may be seen in general how and among whom responsibility for the accident may be divided. It involves nearly all district officials and employees directly connected with the boat and its operations from the time of the purchase inspections till the day of the disaster. Therefore fixation of responsibility in appropriate degree upon individuals cannot now be done.

New and Improved Equipment

Hydraulically Operated Coal Spout Oscillator

A coal spout oscillator, that is operated by means of a hydraulic cylinder, is a recent development of the Coal Spout Oscillator Co., 4148 Chicago Ave., Minneapolis, Minn. Views of the operating mechanism and the general arrangement are shown in the accompanying illustrations.

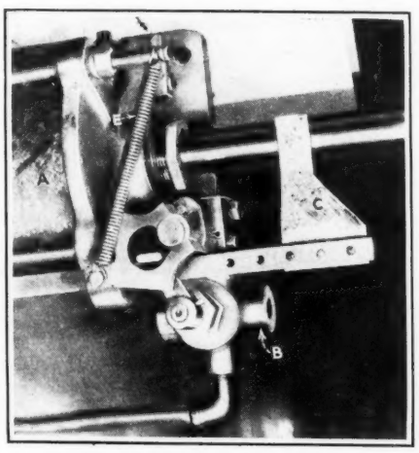


Fig. 1—Mechanism for operating reversing valve

The oscillator is operated by oil pressure supplied to the cylinder *A* through the valve *B*. The valve directs the oil to one end of the cylinder and moves the piston until the hub of the sheave hanger on the end of the piston rod strikes the bracket *C*, which in turn operates the reversing valve *B*. and changes the movement of the piston. The oil pressure is supplied by a gear pump, connected through a flexible coupling or double universal joint to the end of the stoker-drive shaft. A safety or bypass valve fitted in the cover of the pump takes care of any excess pressure on the oil line to the cylinder. This valve allows the oil to bypass within the pump at a pressure considerably above that necessary to operate the oscillator. The speed of the oscillator is regulated by opening or closing the shut-off valve *D*, Fig. 3, in the high pressure line between the pump and the reversing valve *B*.

Fig. 3 shows the general arrangement of the oscillator attached to the front of a boiler to operate three coal spouts. The arrangement shown requires the piston to travel only one-half the distance of the spouts and consequently reduces the size of the apparatus. The cylinder is built from 6-in. extra-heavy pipe and the piston is cast-iron with two split rings.

The reversing valve, shown in Fig. 1, is so designed that should the trip spring *E* break, the valve will be forced to the neutral position and the oscillator will automatically stop.

Under ordinary operating conditions the oscillator moves the coal spouts about one cycle every two minutes. As the speed of the stoker-drive shaft is increased or decreased, the pump and oscillator speed is changed accordingly.

A New Nordberg Diesel

A new design known as the type VH engine has been added to the line of Nordberg Diesels to give a complete range in medium-sized units. Operation is on the full Diesel principle involving the injection of fuel by means of a blast of highly compressed air. The engine is of the two-stroke-cycle, single-acting, vertical type built in three, four, five and six-cylinder combinations, ranging in size from 450 to 900 hp. A cylinder size of 16¾ x 22 in. gives an even rating of 150 hp. per cylinder at a speed of 225 r.p.m.

From previous designs a number of variations have been made to simplify construction and some new features incorporated, such as force-feed lubrication of the bearings, oil cooling of the pistons, the use of crossheads in a comparatively small engine, dual wiper rings on the piston to separate cylinder and bearing oils and what is more apparent in an external view, a box frame inclosing the working parts.

The engine is made up of three principal castings consisting of the bedplate in one piece, the frame and the cylinder bloc, all held together by long through bolts extending from the bedplate to the top of the cylinders. The cam shaft bracket is cast integral with

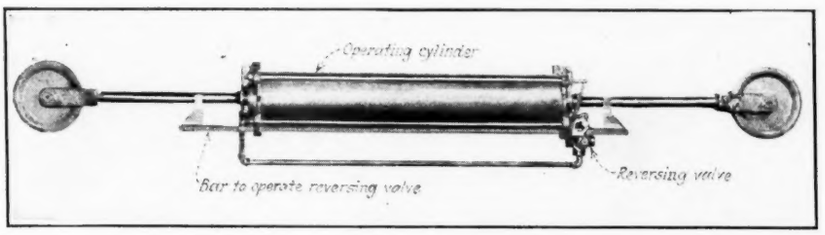


Fig. 2—Detail of operating cylinder

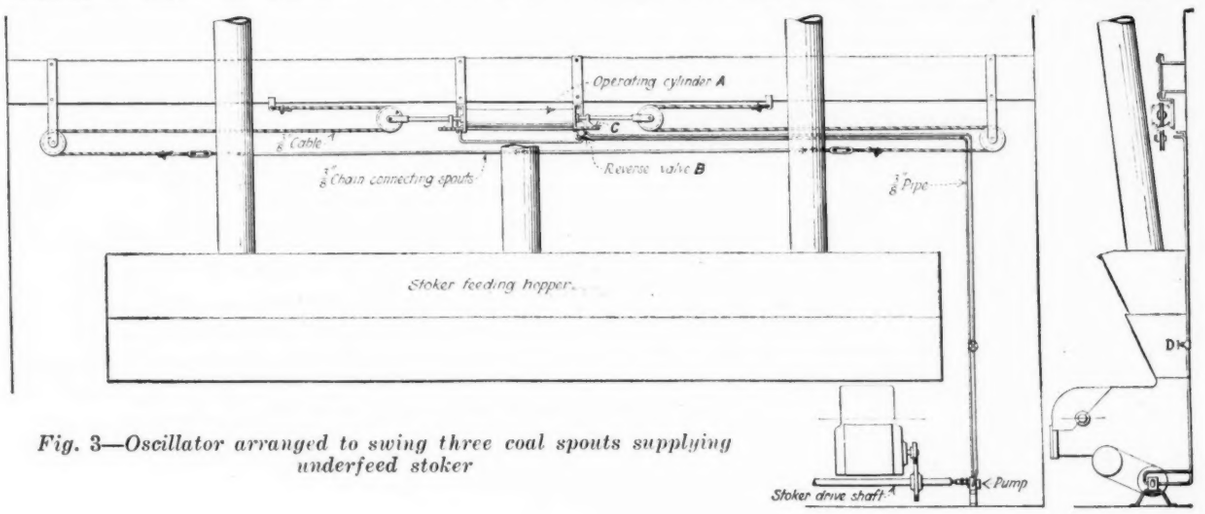


Fig. 3—Oscillator arranged to swing three coal spouts supplying underfeed stoker

the frame and the scavenging air manifold integral with the cylinders. The upper side of this manifold has been made flat to serve as a platform giving access to the working parts above.

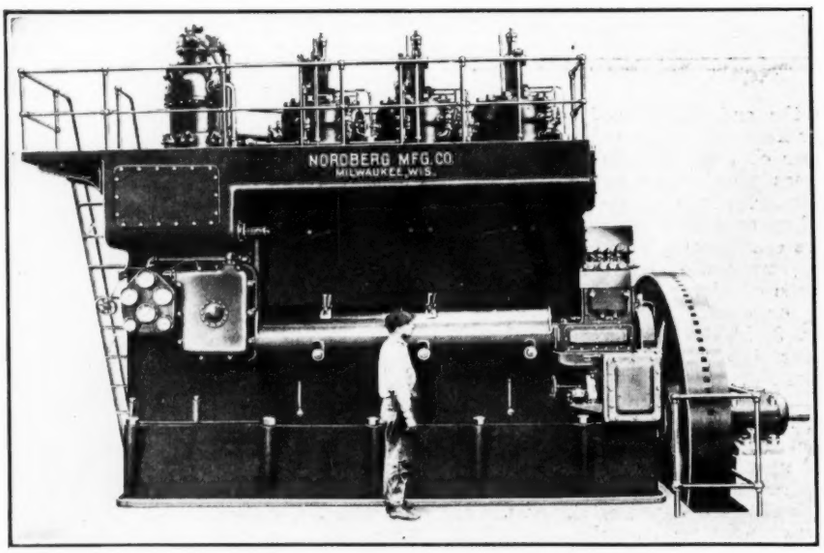


Fig. 1—New type VH Nordberg Diesel engine

Oil, rather than water, is used for cooling the pistons, the supply coming from the pressure lubricating system, which is of sufficient capacity to serve the twofold purpose. Draining back from the bearings into the crankcase, the oil collects in a sump at the air compressor end of the unit. A rotary pump, gear driven from the crankshaft, forces the oil through a twin strainer and a tubular cooler through which all cooling water for the engine is passed, to a pressure header, from which it is distributed to the several main bearings. Continuing through radial holes into a hollow crankshaft, the oil is distributed to the crankpins and crossheads and from the latter passes through a special pipe connection to the piston head where it flows through a continuous spiral passage and returns to the crosshead through a pipe connection on the opposite side, from which it passes out into an open spill pipe leading to the oil sump. At the pump a spring-loaded spill valve, operated manually, is provided to regulate the oil pressure in accordance with the load on the engine. From the pressure header connections are made to lubricate the bearings of the camshaft, governor and fuel pump. Lubrication of the power and air compressor cylinders

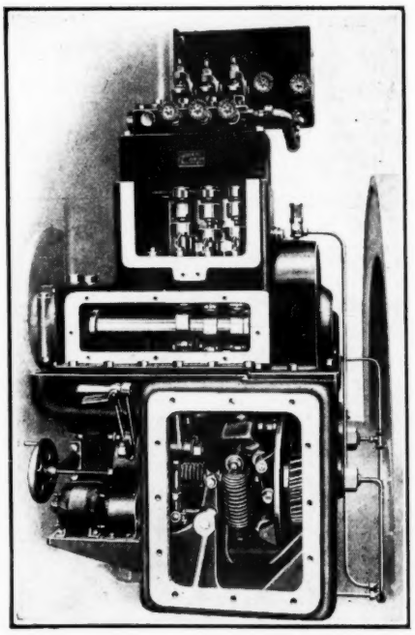


Fig. 3—Fuel pump unit and governor

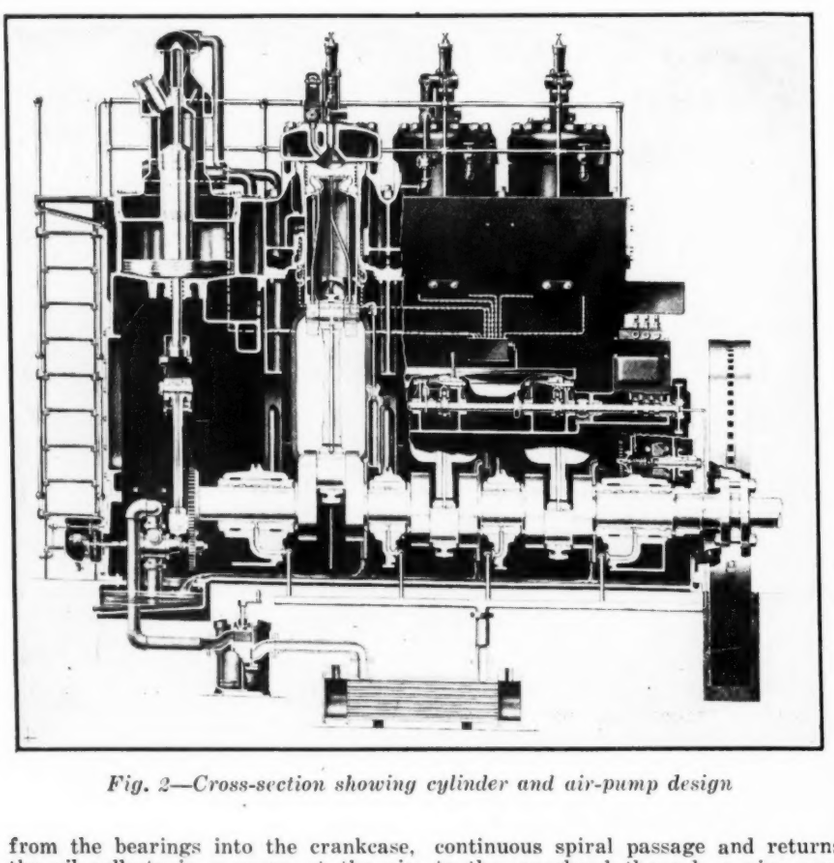


Fig. 2—Cross-section showing cylinder and air-pump design

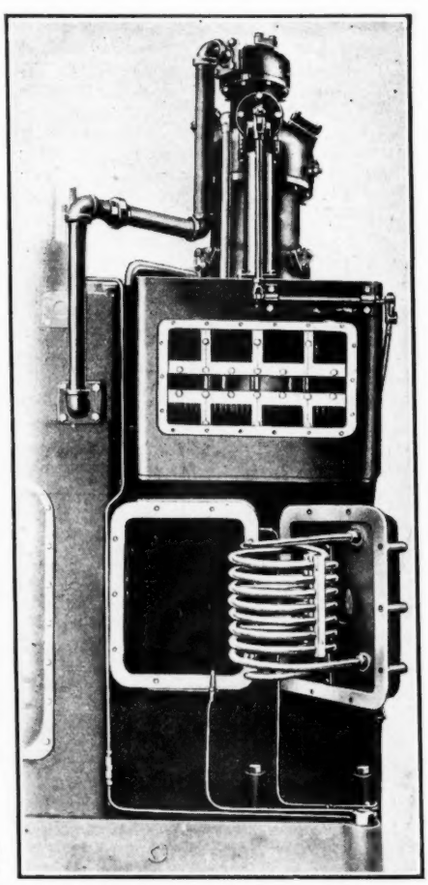


Fig. 4—Side view of scavenging pump and air compressors

is effected by force-feed lubricators driven from the camshaft.

In connection with the lubricating system dual wiper rings at the bottom of each cylinder prevent the contamination of pure oil by the foul oil coming from the cylinder. The upper ring catches the foul oil which is collected and carried to the outside, while the bottom ring wipes off the surplus clean oil coming from the crankpit and returns it to the lubricating system.

The fuel pump, which is of the constant-stroke type, is built up into a complete unit and mounted on top of the governor housing. The body of the pump is made from a forged-steel billet machined to receive the plungers, one for each cylinder, and also the suction and discharge valves which are mounted in cages. The plungers are operated by cams on a camshaft passing through the fuel pump housing and driven by spiral gears from the crankshaft. For priming each pump plunger can be operated by hand.

The governor functions by acting on the suction valves of the fuel pump, closing them earlier or later, depending upon the load and the amount of fuel required. Fig. 3 shows the entire fuel pump unit, the governor and a small motor-driven synchronizing device provided to permit speed control from the switchboard for parallel operation with other power units.

As in previous designs by the same company, the air compressor and scavenging pump are combined into a single unit at the end of the power cylinder and driven from the main crankshaft. The scavenging pump is below, and above is a three-stage compressor to furnish high-pressure air for starting and fuel injection. The former is a double-acting low-pressure pump fitted with strip valves to deliver air to the scavenging header at 3 lb. pressure.

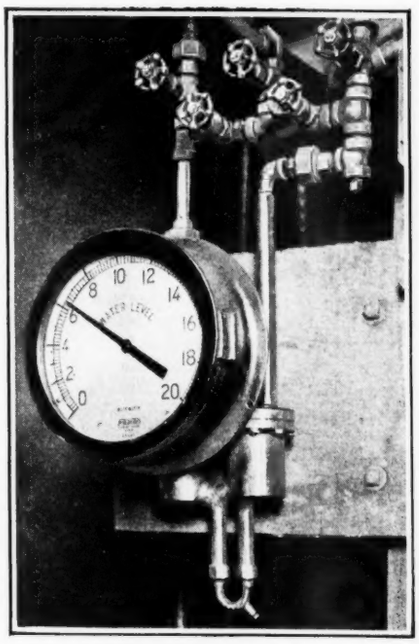
For the air compressor copper-coil intercoolers have been located in cored cavities in the frame, there being an intercooler between the low and intermediate cylinders and the intermediate and high and an aftercooler placed beyond the high-pressure stage. The coils are attached to the covers of these cavities, which, have been designed as water separators to remove moisture entrained with the air. The coils are attached to the covers so that the separator and cooler can be removed as a unit.

Foxboro Boiler Level Gage

The Foxboro Co. of Foxboro, Mass., has recently added to its line of instruments the boiler level gage shown in the illustration. The gage is made in both indicating and recording types, the latter being developed to give a continuous record of the surging or fluctuation of the water level in the boiler.

The instrument operates by the difference in head between maximum high water and any intermediate point, the principle being that of the mercury-float type differential mechanism in which the difference of pressure on each leg of a mercury U-tube causes a deflection of the mercury, actuating the pen arm through the rise and fall of the float.

The indicating gage is installed at eye level on the firing floor and is



Indicating boiler level gage

equipped with a dial having sufficiently large graduations to enable it to be read from a considerable distance.

Kingsbury Recording Smoke Detector

An instrument to indicate the presence of smoke in the boiler flue and make a continuous graphic chart showing the time, duration and density of the smoke produced has been brought out recently by the Engineering Corp., Long Beach, Calif. The instrument which is electrically operated is the invention of E. J. Kingsbury, of Los Angeles, and is known as the Kingsbury Recording Smoke Detector. Application for patents covering the principle and design has been made.

The complete instrument consists of the element, shown in Fig. 1, which is inserted in the boiler flue, a transformer, an indicating and recording unit of the switchboard type and a lock switch. The element is essentially two plates *B* and *C* placed in the primary circuit of a transformer and mounted so that the flue gases pass between them. The conductance between the plates varies with the density of the smoke passing between them. This causes a flow of current in the secondary circuit of the transformer, which in turn is indicated and recorded by the instrument. The graphic record is made on a paper chart ruled for relative smoke densities and traveling 2 in. per hour.

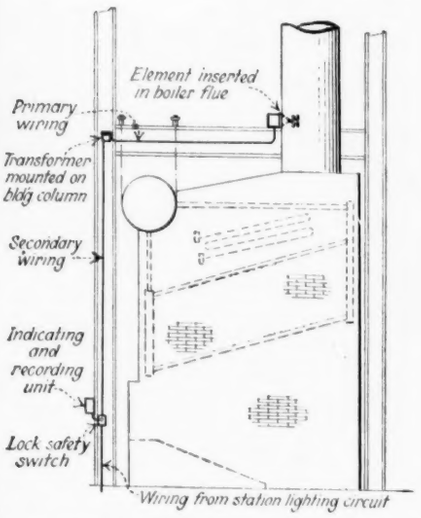


Fig. 2—Typical installation of detector

The element is inserted in the boiler flue a short distance above the connection to the boiler. The transformer may be mounted on adjacent building steel or wall and the indicating and recording unit on the boiler-gage board or wall as desired. Fig. 2 shows a typical installation of the detector on a cross-drum boiler.

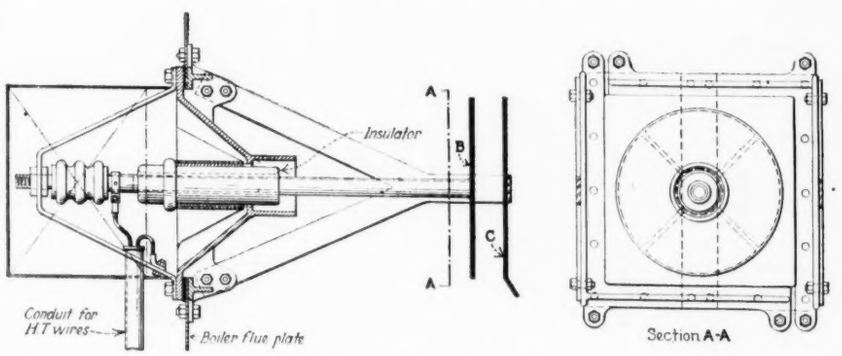


Fig. 1—Detail of element

Roanoke River Project—The Roanoke River Power Co. of Richmond, Va., has applied for a preliminary permit covering a project on Roanoke River near Clarksville, Va. It is proposed to erect a dam 53 ft. high. The spillway crest is to be 1,500 ft. long. Four 12,500-hp. waterwheels are to be installed.

Steamboat Inspection Service Probes "Mackinac" Explosion

Engineer Acknowledges That the Ship Sailed with the Boiler Leaking—Deaths Now Total Fifty-one

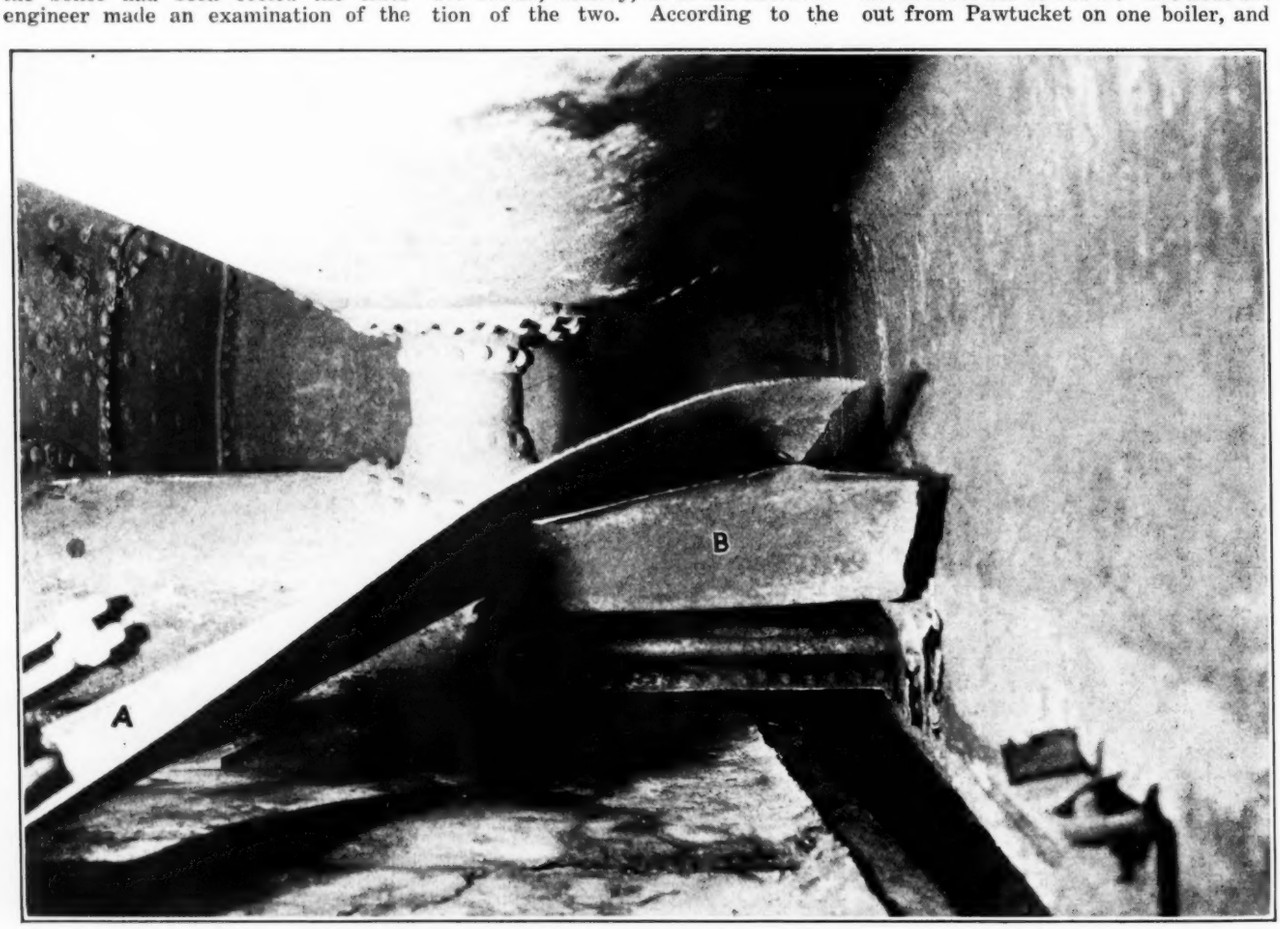
FURTHER investigation of the "Mackinac" explosion, which occurred August 18 at Newport, R. I., reveals that, as indicated in *Power* Aug. 25, the disaster was due to corrosion of the circulating cross drum, leading up to a fracture of the remaining metal. This drum was found to be corroded from its original thickness of $\frac{3}{8}$ in. to $\frac{1}{16}$ in. along the edges of the break.

In the examination held by the United States Steamboat Inspection Service at Providence, Aug. 25 and 26, it was brought out that on the day previous to the explosion Second Engineer Mullins had reported to Chief Engineer Grant that he could hear steam blowing from the circulating drum. That night after the boiler had been cooled the chief engineer made an examination of the drum and discovered what he termed a "pinhole" a half inch or so above the longitudinal seam of the drum and approximately in the middle of its length. He decided that this was but a minor defect and arranged with the Wholey Boiler Works of Providence to have an electric-arc welder on the job early the next morning.

The boiler was emptied, and as soon as the welder arrived he entered the firebox, but after a half hour or so reported to Engineer Grant that there was so much moisture present at the leak as to prevent successful welding of the defect.

Considerable variation existed in the testimonies of the chief engineer and the welder, Cassidy, as to the conversation of the two. According to the welder he reported that instead of a pinhole a crack about 7 in. in length existed, but the engineer denies receiving such a report, although unable to explain his instruction to the welder that "if anything happens, remember your welding job was finished," although acknowledging making such a remark. Neither could he explain his statements made to the Board during the examination on Aug. 21 and before the welder, Cassidy, had made an affidavit to the attorney general of Rhode Island. In the first examination Grant testified that the rupture was a fresh break and that the welders had worked on an old leak in another part of the drum. Under severe questioning he explained that this statement was made on the spur of the moment with the idea of protecting himself against blame.

The engineer testified that he determined to proceed on the trip without repairing the leak inasmuch as he considered it a minor defect. As a safeguard steam pressure was to be reduced from 140 to 100 lb. The boat set out from Pawtucket on one boiler, and



View of Boiler of the "Mackinac." A is part of a steel shield. B is the part of the drum shell which opened up.

as soon as the idle boiler could be filled, steam was gotten up and the boiler cut into the line. This took place some time before reaching Newport.

Chief Engineer Grant denied that any boiler repair was done at Newport, declaring that no trouble arose until the boiler let go when the "Mackinac" was some four miles from Newport. In answer to an inquiry from Inspector General Uhler he stated that minor repair jobs had been performed at various times without notification to the government inspector, justifying himself on the grounds that this was a usual procedure in marine circles. He expressed the belief that pinhole leaks were not to be considered dangerous and could be stopped by welding or calking. It was brought out in his testimony that there was no way by which the interior of the circulating drums could be examined, there being no handholes. He agreed that such openings should have been placed in the water legs opposite each drum end, but felt that this was a matter upon which the inspector should have given instructions.

Assistant Inspector Egan, who inspected the boilers at New York in April, offered testimony that he had given them a hydrostatic test of 50 per cent over pressure, or 220 lb. per sq.in. In addition, he had gone over the entire boiler with the hammer test, emphasizing that the drum, due to its inaccessibility, had been given a thorough hammering. So far as could be discovered, the witness stated, the drum plate was in good condition.

Captain McVey, master of the "Mackinac," could offer little information of value. He testified that Engineer Grant had informed him of some slight boiler trouble but had not later been told that the welder could not remedy the defect. He had every confidence in his chief engineer and left the details of the boiler and engine room operation and repair to him.

The illustration shows the ruptured drum. At *B* is shown the part of the drum shell that opened up; *A* is merely a loose plate originally a part of a shield. Inspection of the illustration reveals to what extent the plate has corroded; at the edge the thickness is about $\frac{1}{16}$ in.

The boiler, only a few of which have been placed on shipboard, is of a design popularly known as the "doghouse" boiler. The cylindrical shell has a diameter of 72 in. and to the sides are attached water legs. The tendency of the two halves of the shell to change shape is resisted by the top row of water-leg staybolts. These bolts are 1¼ in. in diameter. To prevent bulging of the outer sheets of the boiler legs opposite the ends of the circulating drum, long staybolts pass through the drum from outer sheet to outer sheet. One of these can be seen in the illustration. No handholes are provided either in the drum shell or in the water legs whereby the condition of the interior can be examined. As was pointed out in *Power* Aug. 25, the edges of the ruptured sheet show discoloration for several inches, indicating that there was a crack of considerable depth before the sheet let go and that corrosion had thinned the plate over a space about 20 inches long and 3 inches wide.

Smoke-Abatement Program Success in Salt Lake

The smoke problem in Salt Lake City has been abated 95 per cent during the 4½ years' operation of the smoke abatement department of the city engineer's office, it is claimed in a report made by the chief inspector of the department. The report sets forth that whereas the business district was once under a dense smoke cloud, it is now the clearest section of the city.

The inspector in his report says: "The city's future problem is to tighten up on enforcement against plants that violate the ordinance; keep after railroad officials to get firemen disciplined for violation and last to open a campaign of smoke reduction in residences."

Fifty Years of Service Honored by Company

Oskar C. Kirn has completed fifty years of service, an unusual length, as chief engineer with the Quaker Oats Co., of Chicago, Ill. Starting as a millwright under his father at the Akron plant in May, 1875, he has been actively striving to improve the manufacturing conditions of the various plants of the company since. He is reported as being as alert in mind and as vigorous in body today as he has ever been.

A celebration of the completion of the fifty years of service was given in Mr. Kirn's honor by the officials of the company on Aug. 10, at the University Club, accompanied by an appropriate gift and speeches by the chairman of the board of directors and by the associates of Mr. Kirn during many of these years.

Census in the Electrical Industry Reveals Growth

The Census of Manufacturers for 1923 gives interesting tables in regard to prime movers by type, number and horsepower, used in manufacturing electrical machinery, apparatus and supplies for the United States from 1914 to 1923, as follows:

PRIME MOVERS IN THE ELECTRICAL MANUFACTURING INDUSTRY BY TYPE, NUMBER AND HORSEPOWER, FOR THE UNITED STATES: 1923,[1] 1919, AND 1914

Type	1923 Number	1923 Horsepower	1919 Number	1919 Horsepower	1914 Number	1914 Horsepower
Prime movers, total	52,410	480,268	42,468	[2]438,082	17,572	[2]226,320
Steam engines and steam turbines	249	173,853	325	193,231	350	142,085
Internal-combustion engines	60	6,775	103	7,446	181	8,694
Water turbines	25	1,802	17	1,800	19	1,065
Electric motors driven by purchased current	52,076	297,838	42,023	235,605	17,022	74,476
Electric motors, total	95,651	531,257	80,495	479,366	39,568	262,119
Driven by purchased current	52,076	297,838	42,023	235,605	17,022	74,476
Driven by current generated in establishment reporting	43,575	233,419	38,472	243,761	22,546	187,643

COAL CONSUMED, COST OF MATERIALS AND VALUES

United States	Coal Consumed (Short Tons)	Cost of Materials *Dollars*	Value of Products *Dollars*	Value Added by Manufacture *Dollars*
1923[2]	1,417,929	548,626,673	1,293,001,771	744,375,098
1919[2]	1,288,600	425,098,211	997,968,119	572,869,908
1914[2]	844,122	154,728,076	335,170,194	180,442,118

[1] No data in regard to prime movers were collected for 1921.

[2] These figures differ slightly from those published in previous reports because of the exclusion here and the inclusion in the previous reports of data for rented power other than electric.

Girand Will Probably Get Diamond Creek License

All indications are that the Federal Power Commission will withhold no longer than its meeting on Oct. 20 the issuance of a license for the Girand project at Diamond Creek on the Colorado River. So far as it can be learned in Washington, nothing can be said at this time in opposition to the project that was not said at previous hearings in this case. Apparently it is the disposition of the members of the Commission to temporize no longer with the opposition to a project which means a great deal toward the development of the resources of Arizona. It is understood that Mr. Girand plans to transfer the license to a company which will draw its main support from the Arizona copper producers.

R. J. Larkin, Publisher of *National Engineer*, Dies

It is with deep regret that we announce the death of a fellow publisher, Robert W. Larkin, manager of the *National Engineer*. Although Mr. Larkin had been in failing health for several months, his death was a shock to the community in which he lived and to the engineering profession with which he was associated. Paralysis is believed to have been the cause of death as Mr. Larkin suffered his third stroke in June and declined steadily after that, the end coming on Aug. 15, 1925.

Mr. Larkin was born in Dublin, Ireland, in 1865 and came to this country in 1887, establishing himself at once in Chicago with the Chicago Title & Trust Co. In 1898, Mr. Larkin undertook the publication of the *National Engineer* and with the exception of a short interval, has published the paper ever since, living to celebrate a twenty-fifth anniversary of this event. He was a man of unusual force and character and by his associates was respected for his integrity and sincerity. Beside his connection with the National Association of Stationary Engineers, he belonged to numberous political and religious organizations. Surviving Mr. Larkin are his widow, two daughters, Mrs. Clarence Marquart and Miss Margaret Larkin, three sons, Garrett, Robert J. and Richard, all of Chicago.

Two High-Powered Turbines Ordered for Brazil

A contract for two 40,000-hp. impulse turbines for installation in Brazil has recently been awarded the Pelton Water Wheel Co. of San Francisco. These units will be the highest powered impulse turbines in the world. A 45,000-hp. turbine for the Cherokee Bluffs plant of the Alabama Power Co. which will be the highest powered turbine in the Southern States, has been let to the Wm. Cramp & Sons Ship and Engine Bldg. Co. of Philadelphia. This company also owns The Pelton Water Wheel Co.

Low Water on Menominee River Curtails Power

Hydro-plants on the Menominee River, on the Wisconsin-Michigan boundary, which normally develop from 14,000 hp. to 17,000 hp., are requesting industrial power consumers to curtail the use of power owing to the low headwaters of the river. These are at the lowest stage in its history, causing a serious shortage of power. More than half of the power load is being carried by the power company's coal and oil burning standby plants at Iron River, which are operating at full capacity.

Plans Progressing for the Fourth Power Show

The Fourth National Exposition of Power and Mechanical Engineering will be held in the Grand Central Palace, New York City, from Nov. 30 to Dec. 5. This Power Show is a clearing house of information for executives and engineers in all industries. In this it is different from the exhibitions devoted to the equipment of a single industry, as power is a fundamental factor in every industry and a showing of the machines and apparatus required for its economical generation and use gives an opportunity to every industrial executive to discover some means of cutting his promotion costs.

At the coming show a series of exhibits of heating and ventilating machinery will form an important addition to the lines usually represented. This broadening of the scope of the show is an acknowledgment of the increased importance that manufacturers now attach to the need for modern methods in the factory.

The list of exhibitors to whom space has already been assigned indicates the thoroughness with which the field of power generation and use will be covered. From the handling of the coal to the boiler to use of power at the shaft, from the hand shovel to the elaborate coal handling and storing equipment, and from the belt fastener to the enormous pressure mover, every class of device, machine, apparatus or process that enters into power generation and use will be represented. Combustion equipment, valves and fittings for high temperature service, measuring and recording instruments, nonferrous metals and prime movers will have their usual prominent part.

As usual, the annual meetings of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers will be held during the week of the show and their programs have been planned to allow opportunity for a thorough inspection of the exhibits.

World Power Journal Plans Outlined

The quarterly journal which the World Power Conference will publish for one year as an experiment, as announced in *Power*, Aug. 25 issue, page 306, in addition to original material, is to carry abstracts of important articles pertaining to power which have been published in the various countries. Any article, before it will be considered by the editorial staff, must have the approval of the National Committee in the country of its origin. The National Committee also are to furnish statistical information and progress reports.

Provision also is made for the publication of special articles by experts in the various countries, for which payment will be made.

Advertising in the Journal is to be confined to classified directories. Circulation will not be through the usual trade channels, but through the National Committee of each country, which will arrange circulation.

Articles are to be in the language of the country of origin, but comprehensive synopses will appear in English, French, German and Italian.

Brown, Boveri May Buy Shipbuilding Corporation

Arrangements were completed on Aug. 21 for the acquisition of the New York Shipbuilding Corp. by the Brown, Boveri interests of Switzerland, which recently announced plans to extend their electrical manufacturing operations to the United States.

P. A. S. Franklin, head of the International Mercantile Marine and chairman of the New York Shipbuilding Corp., advised all stockholders that an option on the majority of the corporation's stock had been given to the Swiss interests.

Terms of the option, providing for the payment of $30 in cash and $15 in preferred stock, will also be offered to minority stockholders. Those who prefer not to sell probably will be given an opportunity later to exchange their holdings for American Brown, Boveri Co. stock.

Shipbuilding operations at the New York company's plant in Camden, N. J., which reached their peak during the war, will be continued on a smaller scale by the new interests, but it is expected that most of the properties will be converted to the manufacture of electric locomotives and other equipment.

In recommending acceptance of the Brown, Boveri offer Mr. Franklin said that with the diversified production contemplated by the new interests and the high standing they hold in the electrical manufacturing field, the outlook for the Shipbuilding Corp. would appear to be decidedly improved over that which is now possible with activities limited to shipbuilding.

Southeast Becoming Desperate for More Power

To meet a shortage of power in the Southeast which is so acute as to require limitations of street-car service and part-time operation of factories, a proposal has been made to the chief of engineers, in charge of Muscle Shoals, that generator tests be started on the head now available.

The pool behind the Wilson dam is standing at 490 ft. above sea level—eleven feet below the operating level. The chief of engineers on Aug. 24 reiterated his conviction that no more water should be impounded until the Tennessee River shows a gage at Florence of -.7. The gage on that date read -1.6.

There now is line capacity sufficient to take away 85,000 kw. from Muscle Shoals. The steam plant is producing 60,000 kw., its maximum capacity. If the generators were tested with the present head, they could be operated at about 50 per cent capacity. The lines now available could handle the part-capacity output of two generators in addition to the output of the steam plant. This would be of very great moment to the consumers in the South at this time.

The auxiliary turbine that furnishes the power at the Wilson dam for operations on the dam itself, has been tested. This is the first unit of the structure actually to produce power.

Decision Rendered in the Hell Gate Boiler Suit

A decision has been handed down by Judge Knox of the United States District Court, Southern District of New York, in the case of the Babcock & Wilcox Co., plaintiff against the Springfield Boiler Co. and the Superheater Co. The plaintiff held that the defendants had in the arrangement of superheaters and passes infringed upon the patents of Bell and Pratt which are owned by the Babcock & Wilcox Co. in the installation at the Hell Gate station of the United Electric Light & Power Company.

The Court, while admitting certain points of similarity between the installation in question and claims in the Bell and Pratt patents, stated that the Babcock & Wilcox Co. had not tried out these patents in practice and did not know if they were practical and would work. The defendants, he said, were the first to make practical application of these arrangements.

Summing up the case in general, Judge Knox said:

"The net result of my examination of the facts of this case is, that defendants have constructed a type of superheater water-tube boiler that differs materially from those shown and claimed by the patents in suit, and that it is accomplishing results which, if they were contemplated by Pratt and Bell, are brought about by a construction that avoids any valid claim of infringement of the patents granted upon their inventions. It follows that the complaint must be dismissed."

Personal Mention

C. L. Hill has been appointed superintendent of power of the southwestern district of the Puget Sound Power & Electric Co.

John Anderson, chief engineer of the Milwaukee Electric Railway & Light Co. since 1912, has recently been made vice-president of the company in charge of power.

John R. Freeman, past-president of the A.S.M.E., has been honored by receiving the title of Doctor-Engineer conferred by the Technical High School of Dresden, Germany.

Guy Hubbard, who for ten years has been active in the machine-tool industry, has joined the editorial staff of the A.S.M.E. and will have charge of the *A.S.M.E. News.*

Samuel Insull, president of the Commonwealth Edison Co., of Chicago, and president of the National Museum of Engineering and Industry, sailed for Europe, Aug. 18, on the "Aquitania."

Edwin R. Martin, assistant professor of electric power engineering at the University of Minnesota, has resigned in order to take a position with the industrial power division of the Westinghouse Electric & Manufacturing Co. at East Pittsburgh.

Dugald C. Jackson, Jr., assistant professor of electrical engineering at Duke University has been placed in charge of the department of mechanical and electrical engineering at the new Speed Scientific School of the University of Louisiana.

F. G. Tryon, of the Bureau of Mines, has obtained a furlough for a brief period to make a study of the statistics of fuel and power for the Institute of Economics of Washington, D. C. The coal unit of the Division of Mineral Resources will be in charge of James B. Black during the absence of Mr. Tryon.

Fred Dornbrook has been made chief engineer of power plants for the Milwaukee Electric Railway & Light Co. **George J. Lawrence** and **M. K. Drewry** have been named assistant chief engineers of power plants and **Lyness Evans** first assistant engineer of the company's power-plant department.

Ferry C. Houghten, who was appointed secretary of the American Society of Heating and Ventilating Engineers last year, has also been appointed director of the society's research laboratory at Pittsburgh, Pa. Mr. Houghten was connected for several years with the laboratory. He will continue to serve in the dual capacity of secretary of the society and director of the laboratory.

G. H. Bucher, assistant general manager of the Westinghouse Electric International Co. left New York recently for Seattle, Wash., on his way to Japan, where he will assist in the organization of the newly formed Westinghouse Electric of Japan. While in the Orient he will visit China, the Philippine Islands and other Far East Countries to make an investigation into the electrical business outlook in those countries.

Coming Conventions

American Electric Railway Association. James W. Walsh, 8 West 40th St., New York City. Convention and exhibits at Young's Million Dollar Pier, Atlantic City, N. J., Oct. 5-9.

American Electrochemical Society. Dr. Colin G. Fink, Columbia University, New York City. Convention at Chattanooga, Tenn., Sept. 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast convention, Seattle, Wash., Sept. 15-17.

American Institute of Mining and Metallurgical Engineers. H. Foster Bain, 29 West 39th St., New York City. Autumn Meeting at Salt Lake City, Aug. 31-Sept. 3.

American Society of Civil Engineers. George T. Seabury, 29 West 39th St., New York City. Fall meeting at Montreal, Oct. 14-16.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 3.

American Welding Society. M. M. Kelly, 33 W. 29th St., New York City. Fall meeting and Exposition of Welding Equipment and Accessories at the Massachusetts Institute of Technology, Cambridge, Mass., Oct. 21-23.

Association of Edison Illuminating Companies. Preston S. Miller, 80th St. and East End Ave., New York City. Annual meeting at New Arlington Hotel, Hot Springs, Ark., Oct. 19-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, Empire Bldg., Pittsburgh, Pa. Annual meeting at Philadelphia, Pa., Sept. 14-19.

Chemical Industries. Tenth Exposition at Grand Central Palace, New York City. Sept. 28-Oct. 3.

Electric Power Club, S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Fall meeting at Briarcliff Manor, N. Y., Oct. 19-22.

Empire State Gas & Electric Association. C. H. B. Chapin, 5618 Grand Central Terminal Bldg., New York City. Meeting at Lake Placid Club, N. Y., Oct. 1 and 2.

Illuminating Engineering Society. Norman D. MacDonald, 29 West 39th St., New York City. Convention at Detroit, Mich., Sept. 14-18.

Iron and Steel Exposition. John F. Kelly, 706 Empire Bldg., Pittsburgh, Pa., Sept. 14-19. Exposition at the Philadelphia Commercial Museum, Philadelphia, Pa., Sept. 14-19.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4.

National Exposition of Power & Mechanical Engineering. Fred W. Payne, Manager, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Safety Council. G. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Fourteenth Annual Safety Congress at Cleveland, Ohio, Sept. 28-Oct. 2.

New England Water Works Association, Frank J. Gifford, Dedham, Mass., sec. Convention to be held aboard "Richelieu," en route Montreal to Quebec, etc., Sept. 8-11. For details apply to George E. Marsters, Inc., 248 Washington St., Boston, Mass.

J. R. Johnson, formerly chief operator at the El Dorado plant of the Western States Gas & Electric Co., has been appointed superintendent of hydro generation with offices at Placerville.

David Moffat Myers, consulting engineer, 1 Madison Ave., New York City, announces that he is continuing his practice as consultant in industrial power plant design and operation, after Sept. 1, at new offices in the Metropolitan Tower, New York City. The former partnership of Griggs and Myers has been dissolved by mutual consent.

A. C. Fieldner has been appointed chief chemist of the Bureau of Mines to fill the vacancy created in March by the resignation of Dr. S. C. Lind. Mr. Fieldner, who has been in charge of the fuels chemical laboratory at the Bureau of Mines, Pittsburgh station, will continue to serve as superintendent of that experiment station and will have his headquarters there.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Aug. 24, 1925
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1 92
Clearfield	Boston	1.65@ 1.90
Somerset	Boston	1.75@ 2.10
Kanawha	Columbus	1 50@ 1.70
Hocking	Columbus	1.50@ 1.80
Pittsburgh	Pittsburgh	1.90@ 2.00
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.10@ 1.50
S. E. Ky.	Louisville	1.50@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.30@$2.60
Buckwheat No. 1.	Philadelphia	2.50@ 2.75
Birdseye	New York	1.60@ 1.90

FUEL OIL

New York—Aug. 27, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal., 36@40 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Aug. 20, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.85 per bbl.; 26@28 deg., $1.90 per bbl.; 28@30 deg., $1.95 per bbl.; 30@32 deg., $2.00 per bbl.; 32@36 deg., gas oil, 5c. per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh — Aug. 19, f.o.b. local refinery; 30@34 deg., fuel oil, 5¾c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Aug. 22, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

Philadelphia—Aug. 21, 27@30 deg., $2.15@$2.21 per bbl.; 18@22 deg., $1.848@$1.908; 13@19 deg., $1.575@ $1.635 per bbl.

Boston—Aug. 24, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4.2c. per gal.; light oil, 28@32 deg. Baumé, 5½c. per gal.

Cincinnati — Aug. 25, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 5¼c. per gal.; 26@30 deg., 5⅝c. per gal.; 30@32 deg., 5⅝c. per gal.

Chicago — Aug. 25, tank-car lots, f.o.b. Oklahoma, freight to Chicago 92c. per bbl., 24@26 deg., $1.05 per bbl.; 30@32 deg., $1.35.

New Plant Construction

Ala., Florence—U. S. Engineer Office, will receive bids until September 24th for the installation of motor-driven air compressors in the power house and lock operator's house of the Wilson Dam on Tennessee River.

Calif., Los Angeles—Sun Realty & Investment Co., 742 South Hill St., is having plans prepared for the construction of a 12 story office and stores building, including 5 elevators at 7th and Flower Sts. Estimated cost $1,200,000. Corlett & Beelman, 408 Union Bank Bldg., are architects.

Fla., St. Petersburgh—City plans an election September 8th to vote $235,000 bonds for the construction of 2 additional units to power plant.

Fla., Winter Haven—The Haven Breeze Ice Cream Co., is in the market for a 25 ton ice plant.

Ga., Rossville — Peerless Woolen Mills, will soon receive bids for the construction of a mill including an electric power plant. W. H. Sears, James Bldg., Chattanooga, Tenn., is engineer.

Ill., Chicago—City has had plans prepared for the construction of a pumping station at Western Ave. and 49th St. J. Ericson, City Hall, is city engineer. L. D. Gayton, City Hall, engineer of design. Bids will soon be advertised for coal and ash handling equipment.

Ill., Chicago — Young Men's Christian Assn., 822 South Wabash Ave., will receive bids about September 1st for the construction of a 19 story hotel addition, revamping old power plant with addition of two 300 hp. boilers, one 300 k.w. generator, one 30 ton refrigerating machine, remodeling ventilating system and installing 3 passenger and 1 freight elevator. Estimated cost $1,300,000. Berlin & Swern, 19 South La Salle St., are architects.

Ill., South Chicago (Chicago P. O.)—Nye & Jenks Grain Co., 140 West Van Buren St., Chicago, plans the construction of a marine tower including grain elevator machinery operated by motors, etc. at 104th St. and Torrance Ave. here. James Stewart & Co., Fisher Bldg., Chicago, are engineers.

Kan., Topeka—Christ Hospital Assn., 9th and West Sts., will soon receive bids for the construction of a 4 story hospital. Estimated cost $500,000. Schmidt, Garden & Martin, 104 South Michigan St., Chicago, Ill., are architects.

Md., College Park—University of Maryland, is having plans prepared for the construction of an administration building, dining hall and power plant. Estimated cost $225,000. Smith & May, Calvert Bldg., Baltimore, are architects.

Mass., Boston—Boston Ice Co., 110 State St., is in the market for refrigeration and ice making machinery for new plant on Albany St.

Mass., Boston—Hotel Winthrop, C. H. Blackhall, 20 Beacon St., is receiving bids for the construction of a 17 story hotel on Tremont St. Estimated cost $2,000,000. Blackhall, Clapp & Whittemore, 20 Beacon St., are architects.

Mass., Boston — Three Hundred Ninty Beacon St. Inc., c/o C. A. Isenback, 120 Milk St., is receiving bids for the construction of an 11 story hotel. Estimated cost $1,250,000. J. C. Spofford, 36 Bromfield St., is architect.

Mass., Brookline (Boston P. O.)—Phibos Corporation, J. F. Holbrook, Pres., 845 Park Sq. Bldg., Boston, is having plans prepared for the construction of a 10 story hotel at 1492 Beacon St. here. Estimated cost $3,500,000. Wilverman, Brown & Heenan, 51 Cornhill, Boston, are architects.

Mass., Cambridge (Boston P. O.)—M. Greenspan, 31 Milk St., Boston, is having plans prepared for the construction of a 5 story office and stores building at Massachusetts Ave. and Arlington St., here. Estimated cost $750,000. Blackhall, Clapp & Whittemore, 20 Beacon St., Boston, are architects.

Mich., Detroit — Merchants' Warehouse Co., E. Coe, 5620 Federal Ave., is having plans prepared for the construction of a 12 story terminal warehouse and office building, including steam heating system and elevators on West Fort St. Estimated cost $3,000,000. Lane, Davenport & Peterson, Charlevoix Bldg., are engineers.

Mich., Norway — City, J. Gee, Clk., has authorized the construction of a new artesian well and electric pump. Engineer not selected.

Minn., Jordan—J. C. Busch, Clk., will receive bids until September 4th for the construction of an iron removal plant and pump house including the installation of a 100 gal. d.c. pump and motor.

Mo., Cape Girardeau—Community Power & Light Co., 610 Planters Bldg., St. Louis, awarded contract for a 2,500 kva. turbo generator and condenser for power plant here to Westinghouse Electric & Mfg. Co., 717 South 12th St., St. Louis. Owner will construct a power plant building and install traveling crane, switchboard, etc., with own forces. Estimated cost $100,000. H. G. Treichel, c/o owner, is engineer.

Mo., Malden—City voted $50,000 bonds for a new boiler, engine and generator for power plant, 2 new well triplex type pumps 350 g.p.m. capacity, 100,000 gal. tank on tower, etc. F. L. Wilcox, 924 Chemical Bldg., St. Louis, is consulting engineer. I. M. Morriss, mayor.

Mo., St. Louis—Coronado Hotel Co., 1042 International Life Bldg., plans the construction of a 14 story addition to hotel at Lindell St. and Spring Ave. Work to be done under the supervision of P. J. Bradshaw, International Life Bldg., Archt.

N. J., Atlantic City—St. Charles Hotel, St. Charles Place, will receive bids until September 10th for the construction of a 12 story addition to hotel at Boardwalk and St. Charles Place. Estimated cost $500,000. Warren & Wetmore, 16 East 47th St., New York, are architects.

N. J., Newark—Sears Roebuck Co., Arthington and Homan Sts., Chicago, Ill., has leased 38 acres at Port Newark and plans the construction of a group of buildings for millwork and lumber plant. A power house is under consideration. Estimated cost $1,500,000.

N. Y., Buffalo—City will receive bids until September 17th for wiring for light and power, remote control cabinets, switchboard, automatic control, transformers, wires, ducts and conduits, etc. for filter plant at Colonal Ward Pumping Station, Jersey St. Estimated cost $25,000. G. C. Andrews, Municipal Bldg., is engineer.

N. Y., Buffalo—Kushin & Konikoff, 55 Allen St., is having plans prepared for the construction of a 4 story apartment at Delaware and Lancaster Aves. Estimated cost $500,000. J. Geigand, 346 Herman St., is architect.

N. Y., New York—Cranleigh Hospital, A. J. Savage, 37 Bridge St., will soon receive bids for the construction of a 9 story hospital at 159 East 90th St. Estimated cost $500,000. Warren & Wetmore, 167 East 47th St., are architects. H. G. Balcom, 10 East 47th St., is engineer.

N. Y., New York—Ewing, Bacon & Heary, 101 Park Ave., will soon receive bids for the construction of a 17 story addition to office building at 109 East 40th St. Estimated cost $1,000,000.

N. Y., New York—Four Hundred Fifteen Central Park West Corporation, c/o Deutsch & Schneider, 36 Maiden Lane, Archts., is having plans prepared for the construction of a 16 story apartment at Central Park West and 101st St. Estimated cost $1,200,000.

N. Y., New York—F. Fox & Co., c/o W. Mason, 70 East 45th St., Archt., is having plans prepared for the construction of a 17 story loft building at 15 West 47th St.

N. Y., New York—H. A. Murray, c/o J. E. R. Carpenter, 508 Madison Ave., Archt., awarded contract for the construction of a 14 story apartment at 80th St. and 5th Ave. to Dwight P. Robinson Co., Inc., 125 East 46th St. Estimated cost $1,500,000.

N. Y., New York—Paterno Construction Co., 100 East 42nd St., will build a 15 story apartment at 334-344 West 110th St. Estimated cost $1,000,000. R. Candela, 200 West 72nd St., is architect and engineer.

N. Y., Thiells—F. R. Utter, Supt. of Purchase, Capitol, Albany, will receive bids until September 3rd for power house instruments at Letchworth Village here.

O., Cleveland—City will soon award contract for the construction of an addition to lighting plant on East 53rd St. Estimated cost $70,000. H. Kregelius, City Hall, is engineer.

O., Cleveland—Cleveland Electric Illuminating Co., R. Lindsay, Pres., will soon award contract for the construction of a switchhouse at East 70th St. and an electric substation at Clarence and Athens Aves. Estimated cost $60,000 and $75,000 respectively. E. J. Cook, c/o owner, is architect.

Okla., Hinton—City voted $25,000 bonds for improvements to electric light plant. Benham Engineering Co., 512 Gumbel Bldg., Kansas City, Mo., is engineer. H. W. Melter, mayor.

Pa., Allentown—Potruch & Gomery is having plans prepared for the construction of a hotel. Estimated cost $1,500,000. Ritter & Shay, North American Blvd., Philadelphia, are architects.

Tenn., Nashville—Berry Realty Co., will receive bids until Sept. 10 for the construction of a 20 story office building at 148 6th Ave. Estimated cost $500,000. C. K. Colley & Co., 310 Fourth National Bank Bldg., are architects.

Tex., Bastrop—Texas Public Utilities Co., Waco, plans the construction of power plant including the installation of a 20,000 hp. turbine, etc., here, to supply power for nearby towns. Estimated cost $250,000. Company engineers in charge.

Tex., Beaumont—East Texas Electric Co., E. S. Fitz., Mgr., will soon receive bids for the construction of 120,000 kw. capacity power plant. Estimated cost $4,000,000. Company engineers in charge.

Tex., Brownsville — Brownsville Ice & Cold Storage Co., plans the construction of a 45 ton capacity ice and cold storage plant near Rio Grande Ry. station. Estimated cost $100,000. H. S. Haner, is company engineer. Owner will purchase equipment.

Tex., Donna — Donna Irrigation Dist., voted $330,000 bonds and will soon receive bids for irrigation work including dredging canal, pumps, syphon, etc.

Tex., Frost—City voted $65,000 bonds for improvements to waterworks including pumping equipment, mains, etc. H. S. McAllister, Waco, is engineer.

Tex., Mexia—City voted $125,000 bonds for improvements to waterworks system including pumping equipment, water mains, etc. R. D. Morgan, is engineer.

Tex., Victoria—Middle West Utilities Co., Frost Bldg., San Antonio, plans the construction of a steam generating power plant in the Guadalupe Valley here. Estimated cost $500,000. D. G. Reid and B. Schroeder, Chicago, Ill., to act in conjunction with company engineers. Machinery will be required.

W. Va., Huntington—Chesapeake & Ohio R.R., Marshall Bldg., Cleveland, O., awarded contract for the construction of a boiler shop here to Hinkle Construction Co., Cincinnati, O. Estimated cost $400,000.

Wis., Beaver Dam—City plans improvements to waterworks plant including new power for pumping, either steam, electrical or Diesel engines. W. A. Gergen, Clk. Engineer not selected.

Wis., Milwaukee — Fiebrantz Commission Co., 370 State St., is receiving bids for the construction of a cold storage plant. Estimated cost $40,000. Dick & Bauer, 811 State St., are architects. Refrigeration machinery will be required.

B. C., Esquimalt—Dept. of Public Works, Ottawa, S. E. O'Brien, Secy., will receive bids until Sept. 10th for the construction and installation of an air compressor plant here.

Ont., Belle River—Village is having plans prepared for the construction of a waterworks system including centrifugal electric pumps, pumphouse, reservoir, etc., Estimated cost $50,000. A. W. Connor & Co., Metropolitan Bldg., Toronto, are engineers.

Ont., Frankford—Quinte & Trent Valley Power Co., subsidiary of The Canadian Paperboard Co., has had plans prepared for a hydro electric power development including four 1,300 hp. vertical units, horizontal generators, etc. Contracts for construction of power house and 2 turbines complete with gears have been awarded. Kerry & Chase, Ltd., Confederation Bldg., Toronto, Engrs., will purchase two 600 r.p.m., 1,000 kva. horizontal generators, circuit breakers, conduit, switchboard, etc. Estimated cost $250,000.

Ont., Leamington—Tobacco Sales Corporation, has had plans prepared for extensions to factory and engine house including the installation of a boiler, special presses, etc. Estimated cost $35,000.

Que., Cap-de-la Madeleine—R. Morrissette, Engr., will receive bids until Sept. 8th for one 1 stage pump, 8 x 8 in., 150 hp. motor, two 1 stage pumps, 4 x 6 in., 15 hp. motors for the city.